SAMPLING PLAN FOR THE IMPINGEMENT MORTALITY CHARACTERIZATION STUDY AT THE RUSH ISLAND POWER PLANT

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SAMPLING PLAN SUMMARY

An impingement mortality sampling plan is proposed for the AmerenUE Rush Island Power Plant, a 1200-MW(e) facility in Jefferson County, Missouri, located on the west bank of the Mississippi River 40 miles south of the City of St. Louis. The Rush Island Power Plant is subject to the Clean Water Act §316(b) Phase II Rule for its NPDES permit, which requires that impingement mortality be reduced by 80 to 95 percent, compared to a baseline level specifically determined for the facility. To comply with this Rule, the proposed sampling plan will provide information required to complete an Impingement Mortality Characterization Study. This sampling plan: 1) identifies existing data on the fish community in the vicinity of the cooling water intake and on impingement occurring at the intake; 2) evaluates the sufficiency of these data to characterize current fish abundance, distribution, and impingement mortality at the intake; 3) makes a preliminary selection of Representative Species for detailed study; and 4) describes a work scope for impingement monitoring.

The plant's intake operation and the fish community in the Middle Mississippi River may have changed sufficiently since the previous impingement sampling of 1977-1978 to affect the species composition and magnitude of impingement. For these reasons, an impingement monitoring program is proposed that will update existing impingement data to reflect current conditions in the river and current operation of the plant. Data produced by this program will define the species and life stages impinged, as well as their numbers and biomass on a time (biweekly, monthly, and annual) and per-volume-pumped (MG of cooling water) basis.

The Phase II Rule allows impingement mortality to be quantified using Representative Species (RS), chosen to be surrogates for other species not selected for detailed study. RS typically are those most frequently observed in impingement collections, or those deemed to be most important because of their economic value (e.g., commercially or recreationally exploited species), value to the ecosystem (e.g., abundant prey species), or societal value (e.g., threatened or endangered species). Based on impingement studies conducted during 1977-1978, the recommended list of RS includes gizzard shad, freshwater drum, common carp, white bass, flathead catfish, bluegill, channel catfish, and paddlefish. The gizzard shad is recommended as an RS due to its dominance (approximately 95 percent) of the total impingement. The remaining seven species are recommended because of their specific value to the community and as surrogates for their respective taxonomic families.

The table below summarizes the proposed features of the impingement mortality sampling programs.

RUSH ISLAND POWER PLANT SAMPLING PROGRAM SUMMARY

Program	Duration	Sampling Frequency	Data Collected
Impingement Monitoring	1 year	Biweekly over a 24-hour period, year-round	Counts and biomass by species and life stage, length frequency, scale/otolith samples of RS, specimen condition, collection efficiency, ancillary environmental and operation data

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1. INTRODUCTION

ASA Analysis & Communication, Inc. has prepared this Impingement Mortality Sampling Plan for the AmerenUE Rush Island Power Plant (Rush Island), located on the west bank of the Mississippi River, 40 miles south of St. Louis, Missouri. This plan is a component of the Proposal for Information Collection being submitted to the Missouri Department of Natural Resources (MoDNR). Under the Clean Water Act §316(b), an NPDES permittee must demonstrate that the location, design, construction and capacity of its cooling water intake structure represents Best Technology Available (BTA) for minimizing adverse environmental impact. The primary impacts of concern under §316(b) are entrainment of smaller aquatic organisms into the cooling water system or impingement of larger organisms onto traveling screens in the cooling water intake. However, other impacts associated with various technology or operating alternatives also are considered in reaching a BTA decision.

1.1 PHASE II §316(b) REQUIREMENTS

On July 9, 2004, the U.S. Environmental Protection Agency (EPA) published its final Phase II Rule under CWA §316(b). Phase II applies to existing electric generating facilities (construction commenced prior to January 17, 2002) that have cooling water intake structures (CWIS) with a design capacity of 50 million gallons per day (MGD), withdraw water from waters of the U.S., and use 25 percent or more of the water withdrawn for cooling purposes. The Rush Island Power Plant fits this definition for a Phase II facility. Compliance with the Phase II Rule is based on achieving performance standards for reduction of impingement mortality and entrainment set by the EPA on the basis of facility location. The Rule requires that impingement mortality be reduced by 80 to 95 percent compared to a baseline level (i.e., the calculation baseline) specifically determined for the facility. However, Rush Island is not subject to entrainment reduction performance standards because its design intake flow is 5 percent or less of the mean annual flow of the Mississippi River. The design intake flow is 1346 cfs and the mean annual flow was 204,240 cfs for the period from 1958 through 2003 at the USGS Gage #0701000 in St. Louis. Entrainment therefore will not be considered further in this plan.

The calculation baseline is a hypothetical condition representing an intake structure located at the surface and along the shoreline of the source waterbody. The hypothetical intake would have the screen face parallel to the shoreline and traveling screens with the standard 3/8-inch mesh. No prior modifications to the configuration or operation of the intake would have been taken for the purpose of reducing impingement mortality or entrainment.

Under the Phase II Rule, plant operators must comply with the performance criteria by demonstrating that their existing CWISs:

1. Presently comply with these standards (commensurate with a closed-cycle, recirculating cooling water system) or have a design intake velocity $\leq$0.5 fps (relevant to impingement mortality reduction only), known as EPA Compliance Alternative #1;
2. Already comply under existing conditions or will comply after implementation of technology, operational, and/or restoration measures designed to reduce or replace impingement and entrainment losses (EPA Compliance Alternatives #2 and #3, respectively); or

3. Will meet site-specific standards set in lieu of the national standards because of implementation costs “significantly” higher than considered by the EPA or than the derived benefits (EPA Compliance Alternative #5).

The Rule also allows for reduced study requirements if an approved technology (currently limited to submerged wedge-wire screens) is implemented (EPA Compliance Alternative #4).

Besides other documents required with the submission of a permit application, the Rule requires development of a Comprehensive Demonstration Study (CDS), unless the applicant can demonstrate that its facility's intake cooling water flow is commensurate with a closed-cycle recirculating system (EPA Compliance Alternative #1). The CDS has several components, as outlined in Table 1-1. One component is a Proposal for Information Collection, which includes a sampling plan for any proposed field studies necessary to supplement existing information about the source waterbody, its fish and shellfish community, or current impingement mortality rates. If it is determined that existing information might not accurately represent current impingement mortality rates, the sampling plan will address proposed sampling for the Impingement Mortality (IM) Characterization Study, a required component of the CDS. This Impingement Mortality Sampling Plan fulfills this requirement for the Rush Island Power Plant. Additional biological monitoring might be desirable depending on the specific compliance approach being used. Given that a compliance approach for Rush Island has not yet been selected at this early stage in the planning process, plans for such additional studies are not included in this document.

1.2 IM CHARACTERIZATION STUDY

The IM Characterization Study is an integral part of the CDS and the overall determination of BTA compliance. The IM Characterization Study provides information needed for development of all subsequent parts of the CDS, including the Design and Construction Technology Plan, the Technology Installation and Operation Plan, the Restoration Plan (optional), a site-specific determination of BTA (if justified), and ultimately the Verification Monitoring Plan (Table 1-1). The IM Characterization Study provides data on the rates of impingement mortality (and entrainment, when applicable) currently occurring at the plant, as well as a foundation for estimating the calculation baseline, needed for determining the levels of impingement mortality (and entrainment) reduction being achieved at the plant, presently and in the future. The Rule requires that the IM Characterization Study provide:

1. Taxonomic identifications of all life stages of fish, shellfish, and protected species in the vicinity of the CWIS and susceptible to impingement;
2. A characterization of these species and life stages in terms of their abundance and their spatial and temporal distribution, sufficient to characterize the annual, seasonal and diel variations in impingement mortality; and
3. Documentation of current impingement mortality of these species and life stages.

In addition to these basic requirements, the IM Characterization Study can provide information necessary for the permit applicant to choose the appropriate Rule compliance alternative, such as applying for a site-specific determination of BTA. To justify this alternative, the results of the IM Characterization Study are needed to evaluate the benefits of implementing technology, operational, or restoration measures, in terms of the numbers or biomass of fish and shellfish potentially saved by their implementation.

The Phase II Rule allows impingement mortality to be quantified either for all taxa or through the use of Representative Species (RS) as part of the compliance assessment. Representative Species are chosen to be surrogates for other species not selected for detailed study. Representative Species typically are those most frequently observed in impingement collections, or those deemed to be most important because of their economic value (e.g., commercially or recreationally exploited species), value to the ecosystem (e.g., abundant prey species), or societal value (e.g., threatened or endangered species). Since biological information necessary to complete analyses for the CDS are not available for all species, we believe it is both more practical and more technically defensible to base all analyses on Representative Species. In this sampling plan, we provide the technical rationale for a preliminary selection of Representative Species.

1.3 SAMPLING PLAN OBJECTIVES AND ORGANIZATION

This Impingement Mortality Sampling Plan has been prepared to meet the following objectives:

1. To identify and summarize existing data on the fish and shellfish community in the vicinity of the plant's CWIS;
2. To identify and summarize existing data on fish and shellfish impingement within the plant's CWIS;
3. To evaluate the sufficiency of existing data to describe the current fish abundance and spatial and temporal distribution of fish in the vicinity of the plant's CWIS, and the current rates of impingement mortality;
4. To make an initial selection of Representative Species; and
5. To prepare a work scope for a monitoring program required to supplement existing information on impingement mortality at Rush Island.

This sampling plan is being submitted to the MoDNR as part of Ameren's Proposal for Information Collection (PIC) for the Rush Island Power Plant. The Phase II Rule encourages the MoDNR to review and comment on the PIC within a 60-day period, although sampling may begin during this period.

This sampling plan is organized to first present background information on the plant, including the source waterbody (Section 2.1), the cooling water intake design and operation (Section 2.2), historical biological data (Section 2.3), and a discussion of the need for supplemental data for the IM Characterization Study (Section 2.4). Section 3 then describes the fish community in the vicinity of the plant's CWIS, using available historical data. Section 3 also briefly summarizes life history information for Representative Species, with an emphasis on how their life history influences their exposure to impingement at Rush Island. Section 4 describes the recommended sampling scope for impingement monitoring. This program work scopes describes the recommended sampling design, sampling gear and its deployment, sample processing procedures, collection of any required ancillary information, and data analysis. Section 5 describes a quality assurance program that will address data quality concerns.

Table 1-1 EPA's Comprehensive Demonstration Study (CDS) Requirements

Requirement
Proposal for Information Collection
A description of the selected combination of intake technologies, operational measures, and/or restoration measures being evaluated
A list and description of previous impingement/entrainment studies and/or studies on the physical or biological conditions in the vicinity of the CWIS and their relevance to the study
A summary of past or on-going consultations with federal, state, or tribal fish and wildlife agencies and a copy of written comments
A sampling plan for any new field studies proposed and documenting: • methods proposed and those used in similar studies in the same source water body • quality assurance/quality control procedures • description of the study area (including the zone of influence of the CWIS) • taxonomic identification of the sampled or evaluated biological assemblages (including all life stages of fish and shellfish)
Source Water Body Flow Information
CWIS on a freshwater stream or river: • annual mean flow and all supporting documentation and engineering calculations necessary to determine percentage of water body flow utilized by a facility
CWIS on a lake (other than one of the Great Lakes) or reservoir with a proposed increase to the design intake flow: • narrative description of the thermal stratification • any documentation and engineering calculations necessary to show that natural thermal stratification will not be disrupted
Impingement Mortality and Entrainment Characterization Study
Taxonomic identification of the species and life stages of fish and shellfish in the vicinity of the CWIS that are most susceptible to impingement and entrainment
A characterization of the species most susceptible to impingement and entrainment including the abundance and temporal/spatial characteristics
If new information is needed to characterize IM&E, studies must be "of a sufficient number of years…to characterize annual, seasonal, and diel variations."
Samples used to support calculations of reduction of impingement mortality and entrainment; calculation of benefits must be conducted during periods of representative operational flows and flows must be documented
Documentation may include historical data that are representative of the current operation and biological conditions
Identification of threatened or endangered species protected under Federal, State or Tribal law

Table 1.1 (continued)

Design and Construction Technology Plan
Capacity and utilization rate of the facility and supporting documentation including: • average annual net generation of the facility over a 5 year period (if available) of representative operating conditions • total net capacity of the facility • calculations
Explanation of the technologies and operational measures being used or to be employed to meet § 125.94
A narrative description of the design and operation of all design construction technologies or operational measures necessary to meet national performance standards, and information that documents the efficacy for application with the species and life stages expected to be most susceptible to impingement and entrainment (include all design calculations, drawings, and estimates to support descriptions)
Calculations of the reduction of impingement mortality and entrainment of all life stages of fish and shellfish that would be achieved with the technologies or operational measures being adopted based on the Impingement Mortality and Entrainment Characterization Study described above (include all design calculations, drawings, and estimates to support descriptions)
Documents demonstrating that the location, design, construction and capacity of the CWIS technologies reflect BTA
Technology Installation and Operation Plan
A schedule for installation and maintenance of any new design and construction technologies
A list of operational parameters that will be monitored, including location and monitoring frequency
A list of activities to ensure the efficacy of the installed design and construction technologies and operational measures, to the degree practicable, and the implementation schedule
Schedule and methodology for assessing efficacy of the measures in achieving applicable performance standards, including an adaptive management plan for revisions if the standards are not being met
For pre-approved technologies (Compliance Alternative 4), documentation that appropriate site conditions exist for the technologies
Information to Support Restoration Measures
Explanation of why restoration measures would be more feasible, cost-effective, or environmentally desirable than by meeting performance standards or site-specific requirements wholly through use of design and construction technologies, and/or operational measures
A list and narrative description of the restoration measures in place or proposed for implementation, including species targeted
Quantification of the ecological benefits (production of fish and shellfish) from existing and/or proposed restoration measures, as well as a discussion of the nature and magnitude of uncertainty associated with the restoration measures and a discussion of the time frame for accrual of these benefits
Design calculations, drawings, and estimates documenting that the restoration measures, alone or in combination with technology or operational measures, will meet the requirements for production of fish and shellfish

Table 1.1 (continued)

An adaptive management plan to include: • a monitoring plan listing parameters that will be monitored, and describing the frequency of monitoring and criteria for determining success • list of activities to ensure efficacy of the restoration measures, the linkages between these activities and items in the monitoring plan, and an implementation schedule for the activities • a process for revising the plan if new information becomes available or if standards or site-specific requirements are not being met
A summary of past or on-going consultations with Federal, State, or Tribal fish and wildlife agencies and a copy of written comments
If requested, a peer review of items to be submitted as part of the restoration plan
A description of information to be included in a biannual status report
• **Information to Support Site-Specific Determination of BTA**
Comprehensive Cost Evaluation – including detailed engineering cost estimates of the technological or operational modifications proposed in the Design and Construction Plan above
Valuation of the Monetized Benefits of Reducing Impingement and Entrainment (if the site-specific determination is being sought because the costs are significantly greater than the benefits) containing: • description of methodology used • the basis for any assumptions and quantitative estimates • analysis of the effects of significant sources of uncertainty on the results
Site-Specific Technology Plan containing: • a narrative description of the technologies, operational measures, and restoration measures that you have selected and information that demonstrates the efficacy of the technology for species in the vicinity of the CWIS and supporting design calculations, drawings, and estimates • engineering estimate of the efficacy of the technological or operational measures for reducing impingement and entrainment – include site-specific evaluation of the suitability of the technologies or operational measures for reducing IM&E based on representative studies and/or prototype studies and supporting design calculations, drawings, and estimates • documentation that demonstrates the technologies, operational measures, or restoration measures selected would satisfy §125.94 (establishment of BTA) Most of this information will be developed in the Design and Construction Technology Report
Verification Monitoring Plan – two years of monitoring to verify full-scale performance of technologies, operational measures, or restoration)
Plan must include: • frequency of monitoring • duration of monitoring • description of yearly status report to be submitted to the Director

2. BACKGROUND INFORMATION

This section presents a summary of available information on the Rush Island Power Plant regarding its source waterbody (Mississippi River), the design and operation of the facility, and previous biological studies at the plant and in the source waterbody.

2.1 SOURCE WATERBODY

The Rush Island Power Plant is located in Jefferson County, Missouri on the west bank of the Mississippi River at River Mile (RM) 140.3, 40 miles south of the city of St. Louis (Figure 2-1). This area of the Mississippi River is considered part of the Upper Mississippi River (UMR), defined as the 926-mile reach extending from the confluence of the Ohio River at Caruthersville, Missouri northward to the confluence of the St. Croix River at Hastings, Minnesota (Rasmussen and Pitlo 2004a). More specifically, the plant location is in the river reach sometimes called the Middle Mississippi River (MMR), which is bounded upstream by the confluence of the Missouri River and downstream by the confluence of the Ohio River.

The MMR and the Lower Mississippi River or LMR (from the confluence of the Ohio River southward to the Gulf of Mexico) are characterized as the "open reach" or "unimpounded reach" of the river. Unlike the "pooled reach" of the UMR north of the Missouri River confluence, the MMR and LMR do not have dams and locks constructed by the U.S. Army Corps of Engineers (USACE) for navigation purposes. Instead, the MMR has been channelized and has river flow control devices that have evolved over the last two centuries to restrict the river flow to the main navigation channel, prevent river meandering, and control the deposition of sediments (Rasmussen and Pitlo 2004a). These devices include wing dikes that direct the river flow toward the main channel; closing dams placed at the upstream end of side channels to shut off their flow, riverbank revetments to protect against bank erosion, and bendway weirs to scour sediments from places of natural accretion. In addition, levees have been constructed along this reach to prevent floodwaters from entering the floodplain, thus restricting the course of the river flow and modifying the river's natural hydrograph. Maintenance of the navigational channel has required periodic dredging, and placement of the dredge spoils into off-channel areas within the river course has further modified the river features and habitats.

River flow at the Rush Island Power Plant, as measured at the St Louis gaging station (USGS 07010000) 39.7 miles upstream from the plant since 1958 (when the last major upstream flow regulating facility was installed) has ranged from 34,600 cfs to 1,070,000 cfs. This maximum daily flow of 1,070,000 cfs, recorded on August 1, 1993, represented a 500-year flood event (Rasmussen et al. 2004). Mean annual flow during the 10-year period from 1993 through 2002 ranged from 134,000 cfs in 2000 to 439,100 cfs in 1993.

2.2 INTAKE DESIGN AND OPERATION

The Rush Island Power Plant consists of two identical coal-fired 600 MW generating units. Unit 1 began service in April 1976 and Unit 2 began service in March 1977. Both units are fueled by pulverized coal and utilize once-through cooling. The plant has operated as a baseload facility.

The plant's cooling water intake structure is built out into the river approximately 100 feet from the shoreline and is surrounded by water when the river is higher than 392 feet above mean sea level. The face of the intake is parallel to the river flow and is located at the edge of the main channel, thus avoiding the shallower main channel border habitat where fish tend to be more concentrated. The intake consists of four forebays, two for each unit. Within each forebay is a circulating pump for condenser cooling water, so that there are two pumps per unit. Each forebay is divided into two 31.5-foot high x 11.25-foot wide screenwells, each containing a conventional vertical traveling screen that is 10 feet wide and has ½-inch woven-wire mesh. Trash racks run the full length of the intake face, with 3-inch clear bar spacing. A warming line sprays heated water on the trash racks to prevent icing during cold months.

Typically, both circulating pumps are run on each unit. The traveling screens normally are rotated on an automatic timer once every 8 hours for 30 minutes or can be triggered automatically by a head differential. When the screens are rotated, three sets of nozzles located at the top of the screens wash debris from the screens at 80 psi. Debris and fish on the screens are collected in troughs running along both the front and back of the screens. The two troughs join at the downstream front corner of the intake and lead to an inclined pipe discharging to the river.

A system of gates is incorporated into the walls of the screenwells to allow fish to escape the intake. Each screenwell wall has a 6-foot 8.5-inch wide by 21-foot 6-inch high portal through which fish can pass downstream to the next screenwell and eventually out of the intake.

Heated water is discharged from the plant's condensers through a common discharge line for Units 1 and 2 for a distance of approximately 500 feet to a diffuser located in the river channel downstream from the intake.

2.3 HISTORICAL DATA

Union Electric Company (UEC) conducted preliminary fish impingement monitoring at the Rush Island Plant during 1976-1977, and a full year of monitoring during 1977-1978. UEC also conducted sampling of the fish community in the vicinity of the Rush Island Power Plant prior to construction, concurrently with impingement monitoring, and during a five-year period (1980-1984) afterward. The fish community of the Upper Mississippi River also continues to be monitored by the Upper Mississippi River Conservation Committee, a consortium of state and federal resource agencies. All of these studies can contribute to an understanding of the health of the fish community in the river and a projection of the levels of fish impingement that might presently be occurring at the power plant. The following is a brief description of the nature of these studies and the data available from them.

2.3.1 Impingement Studies

UEC (now AmerenUE) conducted impingement monitoring at the Rush Island Power Plant from July 1976 through June 1978 (UEC 1979). The first year of sampling (July 1976-June 1977) was a preliminary evaluation when only Unit 1 was operating, but it also included a few initial months of operation of Unit 2. During this first year of study, 24-hour impingement collections were made on a biweekly basis. A collapse of the impingement sample collection basket caused by bank erosion prevented sampling from July 24 to August 24, 1976, and severe icing in the collection system prevented sampling from December 26, 1976 to February 23, 1977. A total of 1,806 fish comprising 15 species were collected during this first year of impingement sampling (Table 2-1). Gizzard shad dominated the collections with 94.6 percent of the total fish collected, followed by freshwater drum with 3.2 percent. Impingement was greatest in December.

A full year of impingement monitoring of both units began in July 1977 and continued through June 1978. A 24-hour collection was made weekly on a randomly-selected sampling date for a total of 48 collections. Fish impinged during the 24-hour period (0800-0800 hours) were washed under normal screen operation and sluiced into a collection basket system in a coffer dam adjacent to the rear of the intake structure. Manually operated gates diverted the screenwash flow into a 30-inch diameter culvert leading to the ½-inch mesh collection basket. A quality assurance program was conducted that included a review and critique of the scope of work, observations and critique of field and laboratory procedures, statistical recommendations, and a verification of organism identifications (UEC 1979).

Thirty-one fish species belonging to 12 families were identified in the impingement collections of 1977-1978 (UEC 1979). A single species, the gizzard shad, dominated the collections, accounting for 20,292 (94.5 percent) of the 21,480 fish collected and 266 kg (93.9 percent) of the total 284 kg of fish collected. Using fish densities in the samples and the ratio of monthly sampled volumes to total monthly cooling water volume, the estimated total number of gizzard shad impinged was 162,185 fish or 94.8 percent of the total annual impingement of 171,082 fish, and 2,090 kg (94.2 percent) of the total 2,220 kg, for all species combined (Table 2-2). Approximately 95 percent of the impinged gizzard shad were <150 mm in length.

Gizzard shad impingement increased during the fall months of 1977 until peaking in December, then declined from January through March 1978 to much reduced numbers in April through June 1978. The increased impingement in fall and early winter appeared to be related to the decline of water temperatures from 60 °F in mid-November to 34 °F in mid-December. The increase in impingement likely was related to a weakened condition of the gizzard shad, a species known to be subject to natural winter die-offs when water temperatures decline below 52 °F (11 °C; White et al. 1986). At these temperatures, young gizzard shad cease feeding and must rely on the metabolism of lipid reserves for survival. Under these conditions, prolonged cold temperatures, particularly below 8 °C, can result in liver and brain dysfunction and catabolism of body tissues, leading to disorientation and/or death.

The only other species that numerically constituted more than 1 percent of the impingement collections was the freshwater drum (Table 2-2). An estimated 7,318 freshwater drum were impinged, weighing a total of 77 kg. Freshwater drum were impinged throughout the year, but impingement was greatest in late summer and early fall (August-October) and in February (UEC 1979). Other species comprising the 10 most frequently impinged species, in order of declining abundance, included white bass, flathead catfish, common carp, blue catfish, channel catfish, bluegill, bigmouth buffalo, and black bullhead (Table 2-2). None of these eight species comprised more than 0.2 percent of the impingement total numerically. Impingement of species other than gizzard shad and freshwater drum occurred at low levels throughout the year, but increased slightly during February through June.

2.3.2 UEC Nearfield Fisheries Surveys

In 1973-1974, prior to the construction of the Rush Island Power Plant, Woodward-Envicon Inc. conducted surveys of the fish community in the Mississippi River in the vicinity of the plant, as well as Isle du Bois Creek and some backwater areas. The surveys used hoop nets, gill nets, trammel nets, seines, and otter trawl and identified 58 species and 19 families of fish (UEC 1979).

During August 1977 through July 1978, UEC surveyed the river's fish community at 10 sampling sites within 1 mile upstream and 1 mile downstream of the Rush Island Power Plant (UEC 1979). Seven of the sites were sampled by boat electrofishing twice per month for nine of the 12 months. Shallow water (e.g. <8-10 feet) along the shoreline at each site was electrofished for a standardized 30-minute period each time. Other sampling gear used included a 30-foot seine with a 6-foot x 6-foot x 6-foot bag of ¼-inch mesh, 150-foot x 6-foot drift trammel nets, and a 10-foot wide semi-balloon try trawl with a 3.5-inch mesh codend. Sampling gear other than electrofishing proved to be unsuccessful or marginally successful. Based on the catch from all gear types, 53 species of fish belonging to 18 families were found in the Mississippi River in the vicinity of Rush Island.

UEC began a seasonal biomonitoring program in the vicinity of the plant in April 1980, which continued through 1984 (UEC 1988). The objective of the program was to establish a long-term database that could be used to characterize the natural variation in the adult fish and benthic macroinvertebrate populations. The sampling frequency was quarterly, corresponding to the spring (March-May), summer (June-August), fall (September-November), and winter seasons (December-February). Sampling did not occur during the winters of 1981 and 1984 or the spring of 1984 because of river conditions or staff availability. Fish were sampled during daylight using a boat electrofisher at seven shoreline sites ranging from approximately 1 mile upriver to 1 mile downriver from the plant. Collection times at each site were approximately 20 minutes. These surveys identified 39 fish species belonging to 16 families.

When the results of all of these earlier surveys are combined with the impingement results, a grand total of 70 species and 20 families were identified in the mainstem river and adjacent areas (Table 2-2). The most abundant species caught by electrofishing in 1977-1978 and 1980-1984 were gizzard shad, common carp, and freshwater drum, which comprised 45-59 percent, 16-20 percent, and 11-15 percent of the total catch, respectively (UEC 1979, 1988). The most abundant fish in seining samples were emerald shiner (47 percent), freshwater drum (24 percent), river shiner (8 percent), and channel catfish (6 percent) (UEC 1979). The distribution of fish species by habitat type is discussed further in Section 3.2.

2.3.3 UMR Community Studies

The fish community of the UMR has been the focus for federal and state resource agencies for a long time, particularly because the river has supported viable commercial and recreational fisheries. The fish communities of the UMR historically have been under the jurisdiction of the five states bordering on the river: Missouri, Illinois, Iowa, Wisconsin and Minnesota. However, there were multi-jurisdictional management problems, particularly with regard to commercial and recreational fishing regulations. As a result, the Upper Mississippi River Conservation Survey Committee was formed in 1943. This group has grown from an initial membership of 22 fisheries biologists to more than 200 resource managers and is now known as the Upper Mississippi River Conservation Committee (UMRCC). Its goal is to "promote the preservation and wise utilization of the natural resources of the Upper Mississippi River and to formulate policies, plans and programs for conducting cooperative studies." Initially, regarding the river's fish communities, the organization's objectives were 1) to determine the nature and importance of the river's sport and commercial fisheries, as well as factors influencing fish abundance; and 2) to collect data upon which to base uniform fishing regulations.

The UMRCC serves as a centralized source of data collected by past and current studies on the fisheries resources of the UMR. Since its formation, the UMRCC has maintained a continuous collection of commercial fishery data, which are published annually in the UMRCC Annual Proceedings. In addition to the managed fisheries of the five member states, there have been several specific issues that have received the attention of the UMRCC, including the continuing status of fishery resources, adverse effects of municipal and industrial sewage, impacts from annual drawdowns of navigation pools and commercial navigation traffic, and the importance of off-channel and channel areas to the production of riverine fishes. The UMRCC has published the proceedings of its annual meetings, as well as technical reports, newsletters, and annual progress summaries of current scientific investigations. It conducts or sponsors special workshops and symposia, and maintains a technical library and computerized database of over 3,000 documents relating to the UMR. A particularly useful document that it publishes is the UMRCC Fisheries Compendium, which was released recently in its third edition (Pitlo and Rasmussen 2004). It contains a summary of the overall current status of the UMR and provides specific information on fish species collected, in particular the important sport and commercial fishes in the UMR and their life histories.

Another source of historical and current information on the fisheries resources of the UMR is the Long Term Resource Monitoring Program (LTRMP). The LTRMP is an element of USACE's Environmental Management Program authorized by the Water Resources Development Act of 1986. The LTRMP originally was designed as a 10-year monitoring program but now has been extended indefinitely by enactment of the Water Resources Act of 1999. The LTRMP is implemented by the US Geological Survey (USGS), with the cooperation of the resource agencies and universities of the five states and the US Fish and Wildlife Service (USFWS), but is the responsibility of the USACE. The long-term goals of the LTRMP are to understand the river system, determine resource trends and impacts, develop management alternatives, manage information, and produce scientific literature and special reports.

The LTRMP monitors the UMR resources within six river reaches, five on the Upper Mississippi River itself and one on the Illinois River. The study reach most relevant to the Rush Island Power Plant is the open river study reach (RM 29-80), which represents the unimpounded MMR. In order to make all LTRMP monitoring data comparable both spatially and temporally, the LTRMP since 1993 uses a stratified random sampling design (Gutreuter et al. 1995) and standardized sampling methods and gear, including day and night electrofishing, tandem fyke net, tandem mini-fyke nets, gill nets, hoop nets, seine, anchored trammel nets, and bottom trawl. In 2002, the seine, tandem fyke net, tandem mini fyke net, and night electrofishing were eliminated as sampling gear (Ickes and Burkhart 2002).

The LTRMP has surveyed the river annually since 1987 and produces annual reports of its findings. It also publishes an ecological status and trend report at 5-year intervals, the most recent being published for 1990-1994 (USGS 1999). This report includes status summaries for multiple river resources, including fishes and sediment and water quality. Annual status reports containing fisheries data by study reach (Burkhardt et al. 2001) and summaries of fiscal year findings (Hegland et al. 2004) are also published. The Upper Midwest Environmental Sciences Center, which produces the LTRMP documents, provides a graphical fish database browser for the LTRMP data on its website (http://www.umesc.usgs.gov/data_library/fisheries/graphical/fish_front.html) which will plot trend data for a specified range of years by species, gear, study reach, and river stratum.

Lastly, some information on the status and issues involving the fish communities of the UMR is available in the Final Integrated Feasibility Report and Programmatic Environmental Impact Statement for the Upper Mississippi River-Illinois Waterway System Navigation

Feasibility Study (USACE 2004). This study is the USACE's plan for making modifications and operational changes to improve navigation in the river, while meeting the needs of the river ecosystem and ensuring environmental sustainability. The plan incorporates an adaptive management approach and would provide funding and a long-term framework for ecosystem restoration and navigational improvements.

2.3.4 Sufficiency of Existing Information for IM Characterization Study

As described in Section 1.2, the IM Characterization Study requires biological data on the following:

1. Identification of fish and shellfish life stages and species in the vicinity of the CWIS and susceptible to impingement;
2. Their abundance and spatial/temporal distribution, sufficient to characterize the annual, seasonal and diel variations in impingement mortality; and
3. Documentation of current impingement mortality of these species and life stages.

As demonstrated above, there is an extensive amount of information available on the fish community of the Mississippi River in the vicinity of the Rush Island Power Plant that might satisfy the first two requirements. However, there are no current data on impingement at Rush Island, since the only impingement studies were conducted over 25 years ago.

In terms of the river's fish community and its relationship to impingement at Rush Island (the first two items above), sustained trends in annual abundance could cause some species or life stages to become more or less abundant in the vicinity of Rush Island's CWIS, and thus more or less susceptible to impingement. It is also possible that recently introduced species (Rasmussen et. al 2004), such as the grass carp, bighead carp, silver carp, and zebra mussel are affecting impingement totals or displacing the species that were impinged in the past. The data routinely collected for the UMR by the LTRMP provide information on trends of increasing or decreasing abundance of species on a regional (study reach) and river-wide basis since 1987. Recent trends observed in the LTRMP database for individual fish species of importance to the Rush Island CWIS are discussed in Section 3.3. While these data were not collected in the immediate vicinity of the Rush Island intake, the open river study reach of the LTRMP might best represent the habitat present near the Rush Island intake, even though it is 60 miles downriver from the plant.

Improved water quality might affect the abundance and composition of the fish community in the immediate vicinity of the plant's intake. Due to extensive improvements in residential and industrial wastewater treatment, water quality in the UMR has improved since the 1970's (Soballe and Weiner 1998), when impingement monitoring at the plant was conducted. The St. Louis Metropolitan Sanitary District opened the first of two major treatment plants in 1970, and the last large primary treatment facility was upgraded to secondary treatment in 1993 (Soballe and Weiner 1998). Also, Rush Island is located downriver from the confluence of the Missouri River. Inflow from the Missouri River increases the flow of the UMR by about two-thirds and carries a sediment load that is more than twice that of the UMR (Soballe and Weiner 1998). The effect of inflow of the Missouri River on the fish community in the vicinity of the Rush Island intake is uncertain, but it could change based on annual variation in the Missouri River flow.

The third item listed above as information required for the IM Characterization Study, i.e., documentation of current impingement mortality, would not be satisfied by using available data. Impingement monitoring has not been conducted in over 25 years. Therefore, an impingement monitoring program is proposed to document the annual, seasonal and daily impingement rates that reflect the current status of the fish community and the current intake operation.

The remaining sections of this sampling plan are devoted to describing the fish community for the purpose of a preliminary selection of representative species, and to outlining a recommended sampling scope for monitoring impingement at Rush Island.

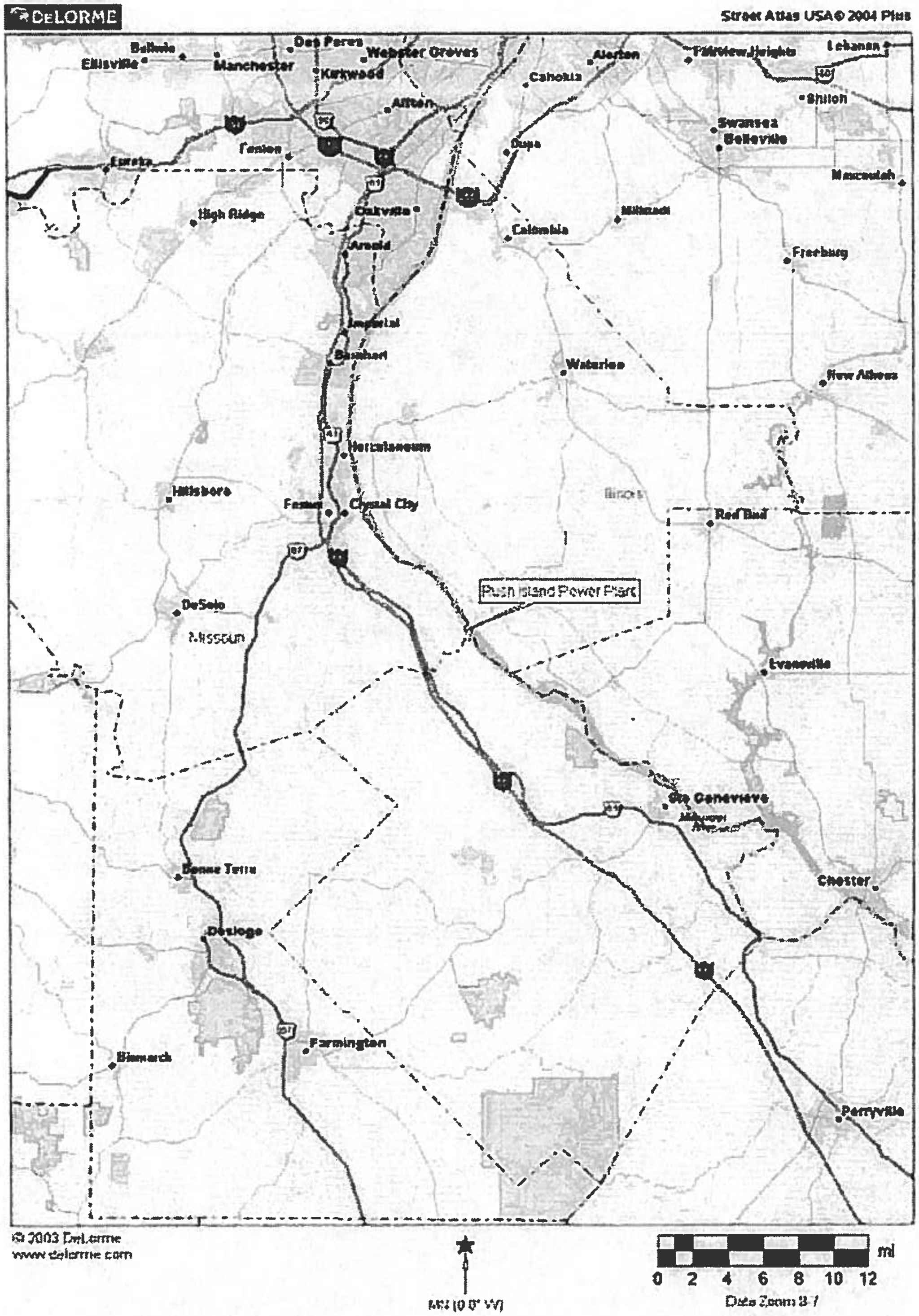


Figure 2-1. Location of the Rush Island Power Plant.

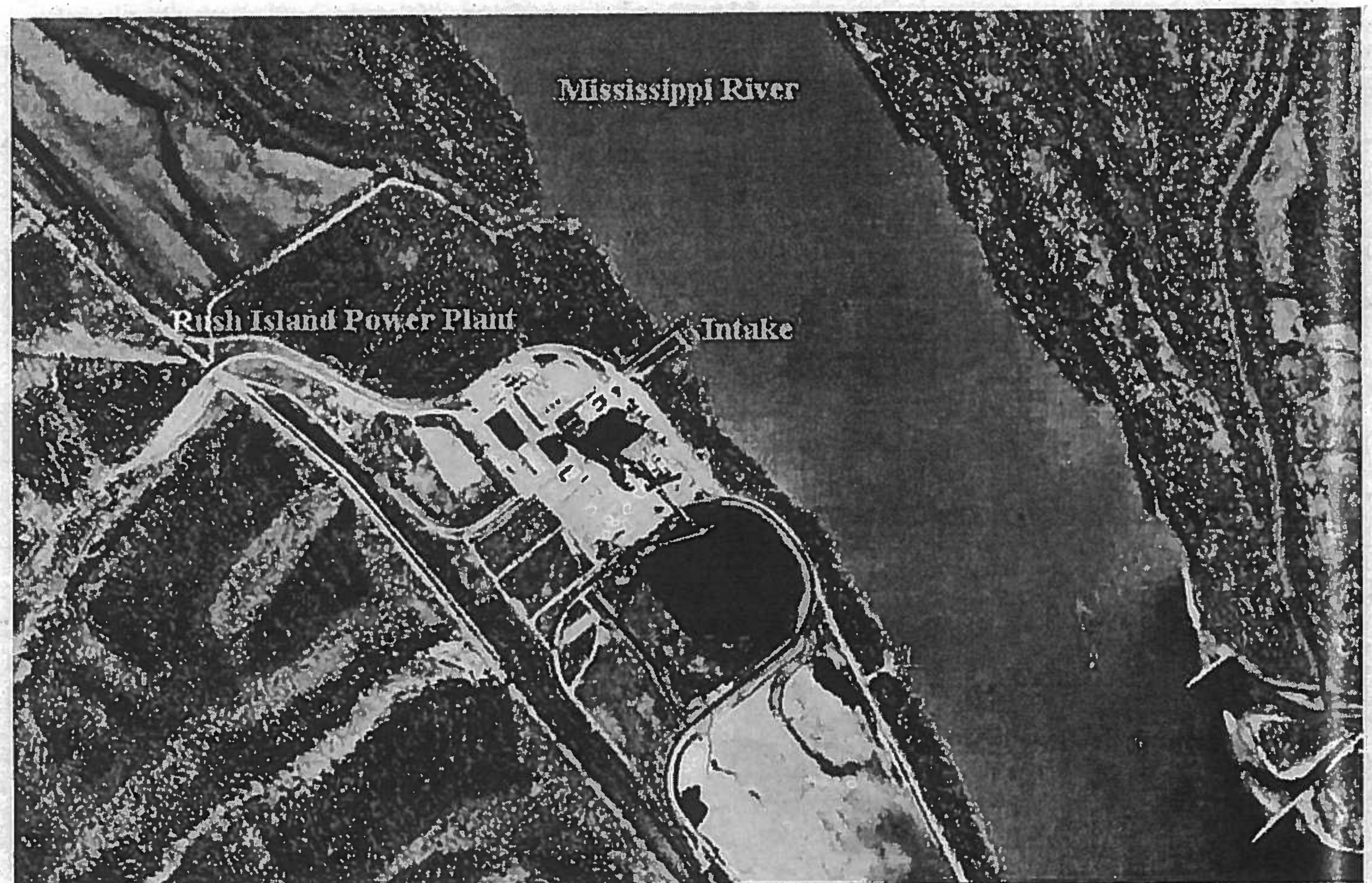


Figure 2-2. Aerial View of the Rush Island Power Plant.

Table 2-1 Impinged Fish Collected at Rush Island Power Plant, July 1976-June 1977

Species	Jul*	Aug*	Sep	Oct	Nov	Dec	Jan**	Feb**	Mar	Apr	May	Jun	Total
Chestnut lamprey										1			1
Silver lamprey											1		1
Gizzard shad				1	22	1,614			8	37	27		1,709
Threadfin shad					1								1
Mooneye										1			1
Common carp						1							1
Quillback						1							1
Blue catfish						8		1					9
Black bullhead										3			3
Channel catfish						1							1
Flathead catfish					1	2		1					4
Green sunfish										3			3
Orangespotted sunfish										2			2
Bluegill										11	1		12
Freshwater drum				1	1	8			6	16	24	1	57
Total	0	0	0	2	25	1,635	0	2	14	74	53	1	1,806

*No sampling July 24 - August 24 due to collapse of collection basket

**No sampling December 26-February 23 due to severe icing in collection system

Table 2-2 Estimated Total Annual Impingement at Rush Island Plant, July 1977-June 1978

Species	Number	%	Weight (kg)	%
Chestnut lamprey	6	0.003	0.329	0.015
Shovelnose sturgeon	8	0.005	0.170	0.008
Paddlefish	6	0.004	0.012	0.001
Longnose gar	11	0.007	1.162	0.052
Shortnose gar	8	0.005	3.914	0.176
Gizzard shad	162,185	94.800	2090.207	94.158
Goldeye	23	0.013	0.355	0.016
Mooneye	62	0.036	1.048	0.047
Common carp	194	0.113	8.020	0.361
Sicklefin chub	21	0.012	0.210	0.009
River carpsucker	27	0.016	0.126	0.006
Quillback	39	0.023	0.305	0.014
Smallmouth buffalo	8	0.005	0.168	0.008
Bigmouth buffalo	76	0.045	10.685	0.481
Silver redhorse	6	0.003	0.085	0.004
Northern redhorse	14	0.008	0.213	0.010
Blue catfish	183	0.107	4.598	0.207
Black bullhead	60	0.035	1.388	0.063
Yellow bullhead	8	0.005	0.344	0.016
Channel catfish	158	0.093	1.634	0.074
Freckled madtom	8	0.005	0.126	0.006
Flathead catfish	205	0.120	1.475	0.066
White bass	207	0.121	12.467	0.562
Rock bass	10	0.006	0.062	0.003
Warmouth	8	0.005	0.059	0.003
Orangespotted sunfish	42	0.025	0.169	0.008
Bluegill	120	0.070	2.099	0.095
Largemouth bass	10	0.006	0.115	0.005
White crappie	21	0.012	0.213	0.010
Black crappie	29	0.017	1.485	0.067
Freshwater drum	7,318	4.277	76.657	3.453
Total	171,082	100	2,220	100

Table 2-3 Species Caught in the Vicinity of the Rush Island Power Plant, 1973-1984

Family	Scientific Name	Common Name
Petromyzontidae-lampreys	*Ichthyomyzon castaneus*	Chestnut lamprey
	Ichthyomyzon unicuspis	Silver lamprey
Acipenseridae-sturgeons	*Scaphirhynchus platyorynchus*	Shovelnose sturgeon
Polyodontidae-paddlefish	*Polyodon spathula*	Paddlefish
Lepisosteidae-gars	*Lepistosteus osseus*	Longnose gar
	Lepistosteus platostomus	Shortnose gar
Amiidae-bowfins	*Amia calva*	Bowfin
Anguillidae-freshwater eels	*Anguilla rostrata*	American eel
Hiodontidae-mooneyes	*Hiodon tergisus*	Mooneye
	Hiodon alosoides	Goldeye
Clupeidae-herrings	*Dorosoma cepedianum*	Gizzard shad
	Dorosoma petenense	Threadfin shad
	Alosa chrysochloris	Skipjack herring
Cyprinidae-carps and minnows	*Cyprinus carpio*	Common carp
	Notropis atherinoides	Emerald shiner
	Notropis buchanani	Ghost shiner
	Hypognathus placitus	Plains minnow
	Platygobio gracilis	Flathead chub
	Phenacobius mirabilis	Suckermouth minnow
	Notropis stramineus	Sand shiner
	Macrhybopsis aestivalus	Speckled chub
	Macrhybopsis meeki	Sicklefin chub
	Macrhybopsis storeriana	Silver chub
	Notropis blennius	River shiner
	Cyprinellus lutrensis	Red shiner
	Notropis shumardi	Silverband shiner
	Notropis volucellus	Mimic shiner
	Pimephales promelas	Fathead minnow
	Pimephales vigilax	Bullhead minnow
	*Campostoma anomalum**	Central stoneroller*
	*Hypognathus nuchalis**	Mississippi silvery minnow*
	*Hypognathus argyritus**	Western silvery minnow*
	*Notropis dorsalis**	Bigmouth shiner*
	*Cyprinella spiloptera**	Spotfin shiner*
	*Pimephales notatus**	Bluntnose minnow*
Catostomidae-suckers	*Carpoides carpio*	River carpsucker
	Carpoides cyprinus	Quillback
	Ictiobus bubalus	Smallmouth buffalo
	Ictiobus cyprinellus	Bigmouth buffalo
	Ictiobus niger	Black buffalo
	Moxostoma macrolepidotum	Shorthead redhorse
	*Moxostoma erythrurum**	Golden redhorse*
	*Moxostoma anisurum***	Silver redhorse**
	*Catostomus commersoni**	White sucker*
Ictaluridae-catfish and bullheads	*Ictalurus furcatus*	Blue catfish
	Ictalurus punctatus	Channel catfish

Table 2-3 (continued)

	Pylodictis olivaris	Flathead catfish
	Ameirus melas	Black bullhead
	Ameirus natalis	Yellow bullhead
	*Noturus nocturnus***	Freckled madtom**
Esocidae-pikes	*Esox lucius**	Northern pike*
	Esox americanus	Grass pickerel
Osmeridae-smelts	*Osmerus mordax*	Rainbow smelt
Atherinopsidae- New World silversides	*Labidesthes sicculus*	Brook silverside
Fundulidae- topminnows	*Fundulus notatus**	Blackstripe topminnow*
Pecilidae-livebearers	*Gambusia affinis*	Western mosquitofish
Moronidae-temperate basses	*Morone chrysops*	White bass
	*Morone mississippiensis**	Yellow bass*
Centrarchidae-sunfishes	*Lepomis cyanellus*	Green sunfish
	Lepomis humilis	Orangespotted sunfish
	Lepomis macrochirus	Bluegill
	Lepomis gulosus	Warmouth
	Lepomis megalotis	Longear sunfish
	Micropterus salmoides	Largemouth bass
	Micropterus punctulatus	Spotted bass
	Pomoxis annularis	White crappie
	Pomoxis nigromaculatus	Black crappie
Percidae-perches	*Sander canadense*	Sauger
	Sander vitreum	Walleye
Scianidae-drums	*Aplodinotus grunniens*	Freshwater drum

*only caught in backwaters or Isle du Bois Creek
**only appearing in impingement collections

3. FISH AND SHELLFISH COMMUNITY

This section describes the aquatic habitat and the fish community in the vicinity of the Rush Island Power Plant. A preliminary list of Representative Species for detailed study is then recommended on the basis of their abundance in previous impingement collections or importance due to their economic value, ecosystem role, or protected status.

3.1 AQUATIC HABITAT

The aquatic habitat in the MMR, and specifically in the vicinity of the Rush Island CWIS, is largely the result of man's attempts to control the flow of the Mississippi River for purposes of commercial navigation (now primarily barges and towboats) and flood control. Navigation channel modifications began as early as 1866 when Congress authorized the USACE to develop a reliable 3-foot deep channel for navigation during low water periods (Rasmussen and Pitlo 2004a). As navigation demands increased, the depth of this channel was increased by subsequent congressional authorizations in 1878, 1907, and 1927 to 4.5 feet, 6 feet, and 9 feet, respectively. Channel modifications first took the form of rock and brush wing dikes used to consolidate the river flow to a single channel. Side channels, backwater areas, and the main channel border (zone between the navigation channel and the riverbank or islands) were blocked by wooden pile dikes and willow mats. Over time all of these structures were fortified or replaced by stronger and higher stone structures. Wing dikes initially were designed to produce a minimum channel width of 200 feet during low water, which in 1927 was increased to 300 feet. Wing dikes have decreased the average width of the MMR from 5300 feet in 1888 to 3,200 feet in 1968 (Rasmussen and Pitlo 2004a). There are now over 800 wing dikes in the 183.5-mile-long MMR. In addition to the channel structures, nearly continuous levees have been constructed in the floodplain along the length of the MMR to prevent flooding of agricultural areas and land developments.

The overall effect of man's modifications of the river channel and floodplain has been a decrease in habitat diversity. The total surface area of the MMR has been reduced. In many places there has been a degradation of the channel bed from scouring, leaving side channels and the original river channel area perched above and isolated from the main channel (Rasmussen and Pitlo 2004a). With the dikes, levees and floodwalls narrowing the channel and isolating it from much of the floodplain, more rapid changes in the water surface elevation have resulted and flood heights have increased, as observed in the St. Louis area (Rasmussen and Pitlo 2004a). Fine sediments are deposited behind the wing dikes, filling in backwaters and side channels. Sand is deposited either in shoals in the main channel or between the wing dikes along the main channel border, usually requiring frequent dredging and sometimes resulting in dredge spoil disposal in the side channel and backwater areas. Ultimately, the ecologically rich side channels and backwaters are destroyed. Research is showing that these areas are very productive and may serve as important resting, spawning, rearing and overwintering areas for many species. Loss of access to the floodplain may have consequences related to nutrient cycling and loss of spawning habitat for certain species.

In the vicinity of the Rush Island Power Plant, the river's navigation channel approaches the west bank, where the cooling water intake is located. At its greatest depth, the riverbed elevation at the intake is approximately 335 feet above MSL, while the surface elevation at median flow is 368 feet (UEC 1979). The width of the river, defined as the distance between the riverward ends of wing dikes on the opposing shores, is approximately 1,400 feet at median daily flow. Diversion of the main channel toward the western shore is largely the result of a series of wing dikes along the eastern shore opposite the plant, which leaves a relatively narrow main channel border along the western bank on the Missouri side of the river and a wider main channel border between the wing dikes along the eastern bank on the Illinois side of the river. The substrate in the main channel and the main channel border consists of hard clay, silt, sand and gravel. Currents in the main channel are moderate to swift. No rooted aquatic vegetation is present within the river. Muddy Creek joins the river on the Missouri side approximately 0.25 miles upstream from the plant, and Isle du Bois Creek joins the river approximately 1.1 miles downriver from the plant on the Illinois side.

Water quality in the vicinity of the plant is influenced by inflow from the Missouri River and the industrialized area of St. Louis. Water quality has improved since the 1970s, particularly with regard to dissolved oxygen (DO) concentration. The median DO concentration according to LTRMP data from 1988 to 1993 was 80 percent of saturation (Soballe and Weiner 1998). Water temperatures may range from 33 °F to 89 °F (UEC 1979). Elevated concentrations of ammonia have been observed near St. Louis. Turbidity and suspended solids are especially high because of the inflow of the Missouri River, whose basin contains highly erodible soils and is intensively farmed. Agriculture is also the major source for pesticides in the river and its sediments. Other contaminants occur, such as the common surfactant LAS (linear alkylbenzene sulfonate), heavy metals (e.g., cadmium), and coprostanol, an organic compound present in fecal matter and associated with sewage contamination from municipal effluents and agricultural feedlot runoff (Soballe and Weiner 1998).

3.2 COMMUNITY COMPOSITION

There are several accounts of the number of fish species found in the UMR, but all of the accounts have one thing in common—the fish community is extraordinarily diverse. At least 260 freshwater species have been reported for the Upper Mississippi River Basin (Gutreuter and Theiling 2004). Fremling et al. (1989) list 193 freshwater species in 27 families for the Mississippi River, while Schramm (2004) reduces the list to 140 resident species by excluding marine, diadromous, and peripheral species, as well as species not recently collected. Peripheral species are defined as those found in tributaries which may temporarily enter the river. The presence of such a great number of species likely is due to the physical complexity of the river system and the diversity of available habitats.

In comparison, a total of 34 fish species were identified in the impingement collections at Rush Island during the 1970's (Section 2.3.1, Tables 2-1 and 2.2), or less than one-fourth of the resident species in the MMR, as reported by Schramm (2004). Fisheries surveys conducted by UEC and its consultants during the 1970s and early 1980s found 70 species (Section 2.3.2, Table 2-2), more than twice the number found during impingement sampling. Three species were impinged but not collected during the fisheries surveys near the plant, and for each species only a single specimen was collected: silver redhorse, yellow bullhead, and freckled madtom. The silver redhorse typically prefers rivers or streams with moderately clear water and avoids the Mississippi and Missouri rivers (Pflieger 1997). The yellow bullhead also prefers clearer water than found in the Mississippi River and is more commonly found in smaller streams and backwater areas, and the freckled madtom is seldom found in large numbers (Pflieger 1997).

The impinged species appeared to come from several river habitats and ranged from being relatively abundant members of the fish community to relatively uncommon or rare species. Nine of the 31 species impinged at Rush Island usually occupy main channel or channel border habitat, 12 species will be found in these two habitat types as well as backwater, and 10 could be classified as being strictly dependent on backwater habitat (e.g., bullheads, madtom, and sunfish) (Schramm 2004). Of the ten species most frequently impinged during 1977-1978, eight are considered to be abundant or common in the unimpounded reach of the Mississippi River: gizzard shad, freshwater drum, common carp, blue catfish, flathead catfish, bluegill, white bass, and channel catfish (Schramm 2004). The bigmouth buffalo is considered to be common or occasionally collected, i.e., not generally distributed but sometimes having local concentrations. The black bullhead is considered to be uncommon, i.e., usually does not appear in survey samples.

3.2.1 Protected Species

There are several fish species in the MMR or the open reach of the Mississippi River that are currently listed as species of concern by the state of Missouri (MCD 2005). There is only one federally listed species, the pallid sturgeon. The pallid sturgeon was not collected during the impingement monitoring programs at Rush Island. State-listed species that were impinged include the sicklefin chub, paddlefish, and mooneye (Section 2.3.1, Table 2-1). These three species are listed with the state ranking of S3[1] and a global ranking of G3 (sicklefin chub), G4 (paddlefish) or G5 (mooneye)[2]. Several environmental organizations petitioned the USFWS to list the sicklefin chub as an endangered species. In April 2001, the USFWS announced its finding that this species does not warrant listing as being endangered or threatened, stating that "while the historic range of the sicklefin chub has been reduced, we have concluded that stable, self-sustaining populations remain widely distributed throughout their range."

Six state-listed species were caught during fisheries surveys in the vicinity of Rush Island Power Plant during the 1970s but were not found in impingement collections. These species and their state and global rankings are as follows: the flathead chub (S1[3], G5), silver chub (S3, G5), plains minnow (S2[4], G4), ghost minnow (S2, G5), western silvery minnow (S2, G4), and Mississippi silvery minnow (S3S4[5], G5). The flathead chub is a state endangered species. It is adapted to turbid waters where the current is swift, and it only occurs in the Mississippi River below the confluence of the Missouri River. Possible reasons for the decline of the flathead chub are nonpoint source pollution, mainstem impoundments impacting flow regimes, and degradation of riparian areas.

Besides the pallid sturgeon, there are state-listed fish species not found in Rush Island impingement collections or in near-field river sampling. Some of these species have been

[1] S3 means that it is "vulnerable" or "rare and uncommon in the state, or found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation".
[2] G3 means that it is "either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range…or because of other factors making it vulnerable to extinction throughout its range." G4 means "widespread, abundant, and apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery." G5 means "demonstrably widespread abundant, and secure globally, though it may be quite rare in parts of its range, especially at the periphery."
[3] S1 means that it is "critically imperiled in the state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state".
[4] S2 means that it is "imperiled in the state because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state."
[5] S4 means that it is "apparently secure", i.e., "uncommon but not rare, and usually widespread in the state", but a "possible cause of long-term concern".

reported within the past 30-50 years as occurring in the Missouri waters of the Mississippi River, tributaries to the Mississippi River such as the Meramec River, or the lower Missouri River (Pflieger 1997, Pitlo and Rasmussen 2004, Schramm 2004). These species include the lake sturgeon (*Acipenser fulvescens*), Alabama shad (*Alosa alabamae*), central mudminnow (*Umbra limi*), sturgeon chub (*Macrohybopsis gelida*), highfin carpsucker (*Carpoides velifer*), blue sucker (*Cycleptus elongatus*), brown bullhead (*Ameiurus melas*), starhead topminnow (*Fundulus dispar*), flier (*Centrarchus macropterus*), and western sand darter (*Ammocrypta clara*). Of these species, the lake sturgeon, pallid sturgeon, and central mudminnow are listed as state endangered species. It is conceivable that some of these species could appear in future impingement sampling at Rush Island.

3.2.2 Exotic Species Introductions

There are several non-indigenous fish species in the MMR that have become important constituents of the fish community, including the commercially exploited common carp. However, none has been as potentially destructive as the recently introduced Asian carp species, including the grass carp or white amur (*Ctenopharyngodon idella*), bighead carp (*Hypophthalmichthys nobilis*), silver carp (*Hypophthalmichthys molitrix*), and black carp (*Mylopharyngodon piceus*). These four species are becoming well established in the UMR system and threaten to disrupt the trophic dynamics of the UMR ecosystem. The bighead carp and silver carp also have become a nuisance, or even a hazard, to the commercial and recreational fisheries of the river due to their large size and propensity to either interfere with the retrieval of commercial fishing gear, or in the case of the silver carp, to jump several feet out of the water when frightened by boat motors, occasionally striking boaters in the process. All have been introduced to the ecosystem either intentionally through stocking interconnecting waterways or accidentally through escapement from captivity.

The grass carp is an herbivore imported from eastern Asia and intentionally stocked to control aquatic macrophyte growth in Arkansas and elsewhere (Rasmussen et al. 2004). Grass carp exhibit rapid growth and can attain lengths up to 63 inches and weights up to 81 pounds. Grass carp even comprised a portion, albeit minor (<1 percent), of the annual UMR commercial fishery harvest between 1976 and 1998 (Rasmussen et al. 2004). Potential negative effects on the UMR fish community are interspecific food competition with invertebrates and native fishes, interference with reproduction of other species, decreased refugia or modification of preferred habitat for other fishes, and introduction of nonnative parasites or diseases (Rasmussen et al. 2004).

Bighead carp is a large species native to large rivers in eastern China. It began to appear in the Mississippi River in the early 1980's. It first appeared in the UMR commercial fishery in 1993 and, together with the silver carp, it contributed a total harvest of 77,230 pounds to the fishery in 1998 (Rasmussen et al. 2004). It reportedly has filled commercial nets to the point that they could not be retrieved so that fishing sites had to be abandoned. The bighead carp has a laterally compressed body and very large head, and can reach lengths of 40 inches and weights of 75-90 pounds. It is adapted to straining planktonic organisms for food, and thus would compete with indigenous planktivores like gizzard shad, paddlefish and bigmouth buffalo, as well as larval fishes and mussels.

Silver carp also is a planktivorous species originating from large rivers in eastern Asia. Its history in the U.S. is largely linked to the bighead carp and its potential impacts on the UMR ecosystem are the same. However, it is a more efficient plankton strainer because its gill rakers are fused into sponge-like porous plates, which allow it to strain small, bacteria-sized particles (Rasmussen et al. 2004). The silver carp is rapidly increasing in abundance in the UMR, where it can reproduce in off-channel and backwater areas.

The most recent Asian carp invader in the UMR is the black carp, for which a specimen, reported to be the second of its kind in the UMR, was caught in June 2004 at RM 273, just below Lock and Dam #24 (UMRCC 2004). Like the others, it is native to Pacific drainages of eastern Asia. It was brought to the US accidentally as a "contaminant" in imported grass carp stocks delivered to an Arkansas fish farm in the early 1970s (Rasmussen et al. 2004). Black carp resemble grass carp but have fused and hardened pharyngeal teeth used for crushing the shells of mollusks, their primary food. They were first released to the wild in Missouri in 1994 when they escaped to the Osage River from flooded holding ponds. Black carp are currently being used in southern states to control snails in fish culture ponds. This species poses a risk to native mollusks and snails.

Although these four Asian carp species will grow rapidly and thus become less vulnerable to impingement at Rush Island, juveniles and an occasional adult specimen could become impinged. Their presence in the long term could affect the species composition and distribution of the fish community.

3.2.3 Current Fish Community Status and Trends

Initial concerns with the status and trends of the fish community in the UMR were related to the commercial and recreational fisheries. The National Marine Fisheries Service kept commercial fishery statistics on the Mississippi River until 1977 and observed a general downward trend in the catch up until that time (Schramm 2004). The UMRCC began keeping the commercial fishery statistics for the UMR north of the Ohio River confluence (thus including the MMR) in 1945 and has continued to maintain the database. Common carp, buffalo species, catfish species and freshwater drum historically have made up 95 percent of the total catch and 99 percent of the value of the UMR commercial fishery (Rasmussen and Pitlo 2004b). These statistics could be altered dramatically with the introduction of the Asian carp species, particularly if commercial markets are developed. Commercial catch of the common carp remained relatively high from 1958 through 1975, but has experienced a decline since then, while the harvest of buffalo, catfish and freshwater drum has nearly doubled during that time interval (Schramm 2004). A quantitative evaluation of the recreational fishery in the MMR is not available.

The LTRMP (discussed in Section 2.3.3) provides annual catch-per-unit-effort (relative abundance or CPUE) statistics for each species, along with other population and community metrics including proportional stock density (size structure), frequency of occurrence in samples, community composition, and species richness (total number of species). Species richness in the Open River Reach at Cape Girardeau downstream from Rush Island shows the number of species caught ranging from 36 to 60. There was an apparent increase from1993 through 2002, followed by a decline in 2003-2004 (Figure 3-1). This pattern, however, may be the result of a reduced number of samples taken during in 1993 and 2003-2004, and hence a reduced probability of capturing less abundant species during those three years. Trends in CPUE of individual species are discussed for selected species in Section 3.3.

There is concern that there may be a decline in species dependent upon backwater habitats if these areas continue to diminish because of siltation and the effects of river flow manipulation for navigation (Schramm 2004). The LTRMP is designed to detect whether these community changes occur though time.

3.3 REPRESENTATIVE SPECIES

Representative Species (RS) typically would be those most frequently observed in impingement collections, or most important because of their economic value, value to the ecosystem, or protected status. In addition to being the target species for evaluating compliance with impingement mortality reductions, RS could be used to estimate the economic losses of fish impingement for a cost-benefit analysis under the EPA site-specific compliance alternative #5 or for scaling restoration efforts and verifying the success of restoration alternatives. It would be important to collect length, weight, and age data from RS during the impingement monitoring program in order to estimate individual growth rates and biomass production for species used in the cost-benefit and restoration analyses. Such detailed analyses would not be possible or practical for all species impinged. Therefore, RS would serve as surrogates for other species of less critical importance or abundance.

Choosing RS for more detailed analysis in impingement sampling at Rush Island is difficult because the fish community, as well as the list of impinged species, is so diverse and there are many species that may be considered prominent because of their abundance or ecological or economic value. On the other hand, impingement at Rush Island in the past has been totally dominated by a single species, the gizzard shad. This dominance of impingement numbers and biomass, as well as its ecological role in the ecosystem, makes the selection of gizzard shad obvious. Of the ten most frequently impinged species, seven species in addition to the gizzard shad may be good indicators of the potential impacts of impingement on the commercial and recreational fisheries of the river and the important families to which they belong: cyprinids (carp and minnows), drum, catfish, centrarchids (sunfish and bass), temperate basses, and the paddlefish (a species of concern).

This section lists the eight fish species recommended for detailed study. The rationale for choosing each species is presented, along with a brief summary of its life history and distribution in the area and recent population trends, if any. As impingement monitoring progresses, this list could be modified to reflect current conditions.

3.3.1 Gizzard Shad

The gizzard shad is one of the most abundant fish species in Missouri, where it occurs in every stream system but is most abundant in the Mississippi and Missouri Rivers (Pflieger 1997). It is so abundant in some locations that it is sometimes considered a nuisance species, possibly competing with other species for food and space. It is a very important prey species in the UMR, providing greater than 50 percent of the food items for species such as largemouth bass, crappie and sauger (Gutreuter and Theiling 1998). Its productivity is linked to its role in the trophic structure of the community, since it feeds on both plants (phytoplankton and periphyton) and animals and is planktivorous. It was by far the most frequently impinged species at Rush Island in the 1977-1978 monitoring program, comprising 94.8 percent of the estimated total annual impingement (Section 2.3.1, Table 2-1). The projected total annual impingement of gizzard shad from July 1977 to June 1978 was approximately 162,185 fish (UEC 1979). Most of the impingement occurred in the fall and early winter.

Gizzard shad spawn in early April and May in shallow water in relatively protected areas (Pflieger 1997). The eggs are adhesive and attach to the bottom. Young gizzard shad grow very quickly, reaching 6 to 7 inches by the end of their first year (Benson 1970). This rapid growth rate limits the period when they are effectively preyed upon to approximately their first six months of life, since by September they become too large for all but the largest predators. Gizzard shad mature in their second or third year of life at ages I-II (Pflieger 1997).

Gizzard shad are more abundant in the lower reaches of the UMR, such as the open river (unimpounded) reach, than in the upper reaches (Gutreuter and Theiling 1998). As young, they are abundant along the shore in late May and June (Pflieger 1997). As adults, they are most frequently found in quiet waters, such as backwaters and pools, where they form large moving schools, often near or at the surface. They feed on algae, plankton and insects by filter-feeding through their gill rakers.

Daytime electrofishing data from the LTRMP for the past 12 years (1993-2004) indicate that their annual abundance can be variable. Peaks in CPUE occurred in the Open River Reach in 1993, 1995, 1998, and 2002 (Figure 3-2). There has been a decline in CPUE during the past two years, 2003-2004.

3.3.2 Freshwater Drum

Like the gizzard shad, in the state of Missouri the freshwater drum is most abundant in the Mississippi and Missouri Rivers (Pflieger 1997). It is an important commercial and recreational fish species in the UMR, being a major component of the harvest of both fisheries. During 1993 to 1996, it ranked first in the summer creel survey conducted on Pools 11 and 13 and has been ranked about fourth in the commercial harvest of the UMR (LaJeone et al. 2004). It was the second-most frequently impinged species during the 1977-1978 monitoring program at Rush Island, with a projected total annual impingement of 7,318 fish (Section 2.3.1, Table 2-1). Freshwater drum were impinged throughout the year, but impingement was greatest in late summer and early fall (August-October) and in February

The freshwater drum spawns in late April and May. Although spawning has not been directly observed, it apparently occurs in shallow, open water, possibly in tributaries to the river (LaJeone et al. 2004). Eggs and larvae are buoyant and drift with the river flow. Adult freshwater drum feed by grubbing along the bottom and consuming mollusks, insects, fish and crayfish. They apparently will feed on zebra mussels, the pest species recently introduced to the river system. Freshwater drum are slow growing and long-lived. They can reach up to 20 inches in length and 10 pounds in the UMR, but most are 1 to 3 pounds in size (LaJeone et al. 2004). Males will mature at ages III-IV and lengths of 11 to 14 inches, while females mature at ages V-VI and 13-15 inches.

The UMR provides excellent habitat for freshwater drum, where they are abundant living on or near the bottom in all pools. It is relatively tolerant of turbidity. In summer months it can be found in nearly all river areas, including tailwaters, but in the winter at water temperatures less than 50°F, it will avoid strong currents and seek deeper side channels and backwaters (LaJeone et al. 2004).

The buoyancy of its eggs and larvae makes this species more vulnerable to entrainment into water intakes and boat propeller wash. The young are also sensitive to near-freezing temperatures in the main channel and side channels during winter, which can lead to overwinter mortality during severe or prolonged periods of cold temperatures if thermal refugia are not available (LaJeone et al. 2004). The LTRMP electrofishing CPUE data from 1993 through 2004 for the Open River Reach show fairly constant numbers of freshwater drum annually after a peak abundance in 1993 (Figure 3-3).

3.3.3 Common Carp

The common carp was introduced into this country from Europe and Asia and was first detected in the Mississippi River in 1883 (Gutreuter and Theiling 1998). It is a dominant species in the commercial fishery of the UMR. In Missouri, common carp have contributed more to the commercial harvest than any other species in 37 of the 47 years of record (Pflieger 1997). The common carp is not actively fished by the recreational fishery. Young carp are preyed upon heavily by large predatory fish species in the UMR. The common carp was the fifth-most frequently impinged species found during the 1977-1978 monitoring program at Rush Island, with 27 specimens collected during sampling (UEC 1979).

The common carp spawns in shallow water from late March to June in the UMR (Hrabick and Petersen 2004). Spawning in the MMR, the southern most portion of the UMR, occurs nearer the start of this time interval. Heavy rains may frequently trigger spawning activity, when carp could move onto flooded portions of the off-channel areas and floodplain to reproduce. They randomly broadcast their demersal, adhesive eggs onto firm substrate. Larval common carp transform to the juvenile life stage at about 0.2-0.3 inches in length and continue to grow rapidly. They begin to mature by age II (12-18 inches and 0.3-0.6 pounds) and usually are fully mature by age V. In the UMR they can reach up to 53 pounds in weight (Hrabick and Petersen 2004).

Larvae can be found in the UMR from late April through June in littoral areas during daylight. At night, they disperse more evenly among habitats and can become more vulnerable to capture and the effects of barge traffic (Hrabick and Petersen 2004). Fry and juveniles tend to concentrate in shallow, weedy backwater areas but will occur in a variety of habitats. Adult common carp are considered to be habitat generalists, but are often found aggregating in deep pools around cover and may overwinter at these depths. Common carp adults usually are not highly migratory. They are omnivorous bottom feeders, often being accused of competing with native species, such as the native buffalo fishes, and causing negative impacts by consuming fish eggs, uprooting vegetation and increasing water column turbidity by their winnowing of the bottom for food. If this is true, their effects might be less in the open reach of the river, such as the MMR, then in the pooled portion of the UMR to the north, where there is more vegetation. The catch rate in the Open River Reach also appears to be lower than the rest of the UMR and the LaGrange Pool of the Illinois River (Gutreuter and Theiling 1998, Hrabick and Petersen 2004).

Commercial harvest records have indicated an overall decline in abundance of common carp since the 1970's. Daytime electrofishing during LTRMP surveys from 1993 through 2004 indicate annual fluctuations in abundance of common carp in the Open River Reach, with peaks during 1994-1996 and 2003 (Figure 3-4).

3.3.4 Flathead Catfish

The flathead catfish is a large, predatory riverine catfish species that is actively pursued by commercial fishermen and recreational anglers. It is larger than the channel catfish but smaller than the blue catfish. The flathead catfish is capable of reaching trophy sizes, sometimes exceeding 65 pounds while reaching a state record of 98 pounds in Missouri waters (Brummet and Jones 2004). It was the fourth-most frequently impinged fish species during 1977-1978 monitoring program at Rush Island and the most frequently impinged catfish species, with 32 specimens being collected during sampling (UEC 1979).

Flathead catfish spawn in late June or early July by excavating depressions in the substrate, usually near submerged objects, and laying eggs in a golden-yellow mass. The male parent guards the nest until approximately 1 week post-hatching, when the young leave the nest. Flathead catfish mature at ages IV to V or about 18 inches in length (Brummet and Jones 2004). They may live up to 28 years.

Young flathead catfish inhabit shallow areas, feeding mostly at night. Larger fish occupy deeper water but continue to feed at night on other fish and crayfish. A study conducted in Mississippi River on the flathead catfish indicated that its abundance was related to the amount of mature forested area in the riparian zone and the amount of snags available in the river (Brummet and Jones 2004). Adult flathead catfish usually have a short home range in the river (e.g., <1 mile), but tagging studies have shown a small percentage (15 percent) to travel distances greater than 20 miles. During warm months, adults can be found in all river habitats except backwaters. In the winter, adults become relatively inactive, staying near structures such as boulders and log piles.

Daytime electrofishing during LTRMP surveys from 1993 through 2004 indicate fairly constant numbers of flathead catfish annually in the Open River Reach, with a recent peak in abundance in 2003 (Figure 3-5).

3.3.5 White Bass

The white bass is a relatively abundant species in the UMR and is rated by anglers as a fair to good food fish and an excellent sport fish (Sallee et al. 2004). In angler surveys conducted between 1962 and 1973, white bass was ranked from fourth to sixth in the recreational catch. It was the third-most frequently impinged fish species during the 1977-1978 monitoring program at Rush Island, with 207 specimens being collected during sampling (UEC 1979).

White bass spawn during April through mid-June over rocky or gravelly shoal areas in the river, often making spawning runs into tributaries (Pflieger 1997). They broadcast their eggs, which then adhere to rocks or debris. They provide no parental care. The free-swimming fry and young begin to school and gradually add small fish to their diet. White bass are relatively fast-growing and short-lived. They mature at ages II-III at a length of approximately 8-10 inches (Sallee et al. 2004). White bass in the UMR can reach a maximum length of 18 inches and a maximum weight of 3 pounds.

The UMR provides excellent habitat for white bass in all of its reaches, although the LTRMP data indicate they are slightly more abundant in the southern reaches (including the Rush Island area) than in the more northern reaches (Gutreuter and Theiling 1998). White bass are known as channel dwelling, being found schooling in both the main channel and side channels. They also frequent the fast water below wing dams and the tailwaters below navigation dams (Sallee et al. 2004). White bass adults migrate during the spawning season over wide areas of the UMR.

During the past 12 years, white bass in the Open River Reach were particularly abundant in 1993, the year of the 500-year flood, as shown by LTRMP daytime electrofishing CPUE (Figure 3-6). After 1993, their abundance has been considerably lower but stable.

3.3.6 Channel Catfish

The channel catfish is a very important and highly desirable commercial and recreational fish species in the UMR. From 1953 through 1987, the channel catfish and flathead catfish together represented approximately one-third of the total value of commercial harvest from the UMR (Pitlo 1997). It was the seventh-most frequently impinged fish species during the 1977-1978 monitoring program at Rush Island, with 20 specimens being collected during sampling (UEC 1979).

Channel catfish spawn in May and June when water temperatures reach 65°F or more (Pitlo et al. 2004). Often there are two spawning peaks, as apparent from a bimodal size distribution of young catfish. Several weeks prior to spawning, males select and clear suitable nest sites, usually consisting of secluded, dark areas such as hollow logs, drift piles, undercut banks, muskrat or beaver burrows, or rip rap. Eggs are deposited in a gelatinous mass. The male tends the nest while eggs hatch and stays there for about 1 week to guard the fry. Fry are less vulnerable to predation in turbid water. Early growth is variable among year classes and apparently is dependent upon existing conditions (Pitlo et al. 2004). As adults, they can grow to more than 25 pounds and 36 inches. Channel catfish begin to mature at age IV and 12 inches in length, and 75 percent are mature by age VI.

Young channel catfish occupy the main channel or main channel border habitats during their first year (Pitlo et al. 2004). Adults may be found in many habitats including channels and large open areas, but prefer habitat with woody debris, bank cavities and moderate currents (Koel et al. 1998). In daylight they seek depths with cover and current. At night or in rising water levels they feed in shallower depths. Most channel catfish do not stray far from their home pool, but some have been shown to make extensive movements (Pitlo et al. 2004).

In the years preceding 1984, there were indications of overharvest of channel catfish in the UMR (Pitlo et al. 2004). In 1984 the minimum size limit for the commercial fishery was raised from 13 to 15 inches to increase the size of the brood stock and recruitment of young. There are indications that this measure has been successful and that their numbers are increasing (Pitlo 1997). The daytime electrofishing data collected in the Open River Reach by the LTRMP from 1993 through 2004 appear to show peak densities in 1998 and 2002, and a decline during 2003-2004 (Figure 3-7). There is concern for destruction of channel catfish spawning habitat from either dredge spoil disposal or sedimentation in backwater areas (Pitlo et al. 2004).

3.3.7 Bluegill

The bluegill is a panfish species that is highly prized by anglers and is also ecologically important as a forage species, particularly to the north in the impounded portion of the UMR. It serves as prey to many game species such as the flathead catfish and largemouth bass, and as a host for 14 species of native Unionid mussels (Cornish and Welke 2004). It was the eighth-most frequently impinged fish species during the 1977-1978 monitoring program at Rush Island, with 17 specimens being collected during sampling (UEC 1979).

Bluegills spawn from late May to August in the UMR, with peak spawning in June. Bluegills are colonial breeders in the sense that spawning fish build nests that are usually in close proximity to each other. Males construct nests that are about 1 foot in diameter in shallow water (depths of 1 to 3 feet). The eggs from several females can be fertilized and deposited in the nest, which is then defended by the male until the eggs have hatched. Because the nests are located in shallow depths, water level fluctuations can severely impact successful reproduction, as nests can be stranded by a lowering water level or disrupted by severe wave action (Gutreuter and Theiling 1998, Cornish and Welke 2004). Bluegills mature by ages II-III and can reach a length of 7 inches by age IV. Maximum sizes in the UMR are about 12 inches and 2 pounds (Cornish and Welke 2004).

Bluegills occur in all river habitats but are most frequently found in backwater habitats such as shallow river lakes and sloughs containing vegetation and woody debris (Gutreuter and Theiling 1998, Cornish and Welke 2004). They are widely distributed and abundant in the UMR but may be limited locally by the amount of backwater habitat. Recent LTRMP data (1993-2004) indicate that their densities, measured by daytime electrofishing CPUE, are lower in the unimpounded, Open River Reach, which would have less or more unstable backwater habitat, than in the impounded reaches of the UMR. Bluegills are not particularly migratory but do exhibit local (e.g., up to 1.5-7 miles) or seasonal movements.

The future abundance of the species may be affected by the continual sedimentation and filling of backwater areas and by water level fluctuations, particularly during the winter. Overwinter survival is dependent on a sufficient dissolved oxygen concentration and sufficient water temperature (e.g., 34.7°F) and water depths (e.g., 3 feet) to allow movements beneath thick ice and snow cover (Cornish and Welke 2004). A decline in bluegill abundance may be avoided to some degree through planned restoration of backwater areas. LTRMP data from 1993 through 2004 show peaks in abundance in the Open River Reach in 1993 and 2001 (Figure 3-8).

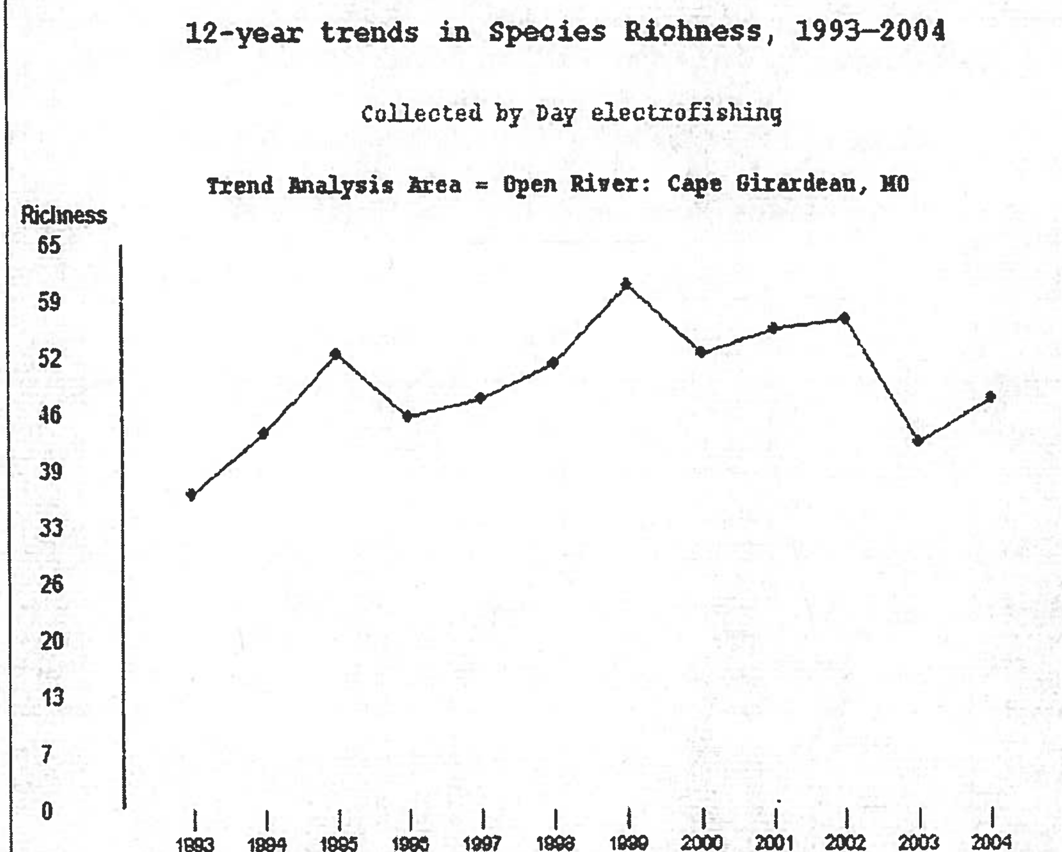
3.3.8 Paddlefish

The paddlefish is recommended as a RS because of its importance as a commercial and recreational species, and because the status and health of its population in the UMR has received so much recent attention. It is listed as a commercial and sport fish species in Missouri and Illinois, a sport fish in Iowa, and a species protected from harvest in Minnesota and Wisconsin. The paddlefish is a planktivorous fish which reaches sizes of 60 pounds to 200 pounds (Runstrom et al. 2004), but is harvested at smaller sizes (e.g., an average length of 26 inches and average weight of 12.75 pounds in Illinois). Several states have listed the species as endangered, threatened or species of special concern. In Missouri it is considered rare or uncommon. In 1989, the USFWS was petitioned to list the paddlefish as a threatened species under the Endangered Species Act, but existing data were inadequate to make a final determination. In 1994, the paddlefish was listed as Category 2, defined as a species that may warrant listing but information to do so is lacking. Six individuals were collected during impingement sampling at Rush Island in 1977-1978 (UEC 1979).

The paddlefish is particularly vulnerable to overharvest because it is late-maturing and is an infrequent spawner. In the UMR, females do not begin to mature until age VI and are not fully mature until age XII. Males start to mature at age IV and are 100 percent mature by age IX (Runstrom et al. 2004). Although there is still some uncertainty about the frequency of their spawning, there is some evidence that females only spawn once every 2 to 5 or so years because ova development may take more than 1 year (Runstrom et al. 2004). Spawning appears to occur in late May, usually timed with an increase in river discharge. Paddlefish spawn in swift currents (1.3-5.2 fps) over gravel and rubble, and their eggs are demersal and adhesive. Young begin filter-feeding at about 5 to 10 inches in length.

There are very limited data on the early life history and distribution for paddlefish. Larvae have been found in the Wisconsin and Chippewa Rivers, tributaries to the UMR, but specific spawning locations are not known (Runstrom et al. 2004). The population dynamics and movements for the species currently are being intensively studied by organizations such as the Mississippi Interstate Cooperative Resource Association (MICRA), whose study will span from 1995 to 2005. It is known that adults strongly select the tailwaters of dams in the spring and summer, and frequently associate with structures such as eddies, holes and current breaks. They can inhabit the main channel border or backwaters, moving to the main channel border as river discharge decreases, and prefer deeper water.

The status of the paddlefish population has been of concern since the early 1900's. Peak harvest of paddlefish occurred in 1899, and harvest levels have continually decreased until they are now less than 10 percent of the 1899 harvest (Runstrom et al. 2004). The decline in its abundance may be attributed to several factors in addition to its late maturity and infrequent spawning. These factors include river modifications for navigation, hydropower and flood control, leading to loss of critical habitat and restricted movements; injury from boat propeller strikes and larval losses from turbulence and shoreline dewatering from boat traffic; and overharvest. Paddlefish are harvested for their valuable flesh and roe, with roe now becoming a more valuable commodity as international caviar supplies decline (Runstrom et al. 2004). Existing data appear to indicate that most populations currently are declining or relatively stable at low levels. Paddlefish face a new threat from potential competition with recently introduced large planktivores, i.e., bighead carp and silver carp. The great mobility of this species and the long-range movements that it exhibits require that its management be coordinated at the multi-state level, such as the UMRCC and MICRA.



Year	Richness	Number of Samples
1993	36	17
1994	43	42
1995	52	54
1996	45	52
1997	47	55
1998	51	37
1999	60	49
2000	52	53
2001	55	57
2002	56	57
2003	42	27
2004	47	45

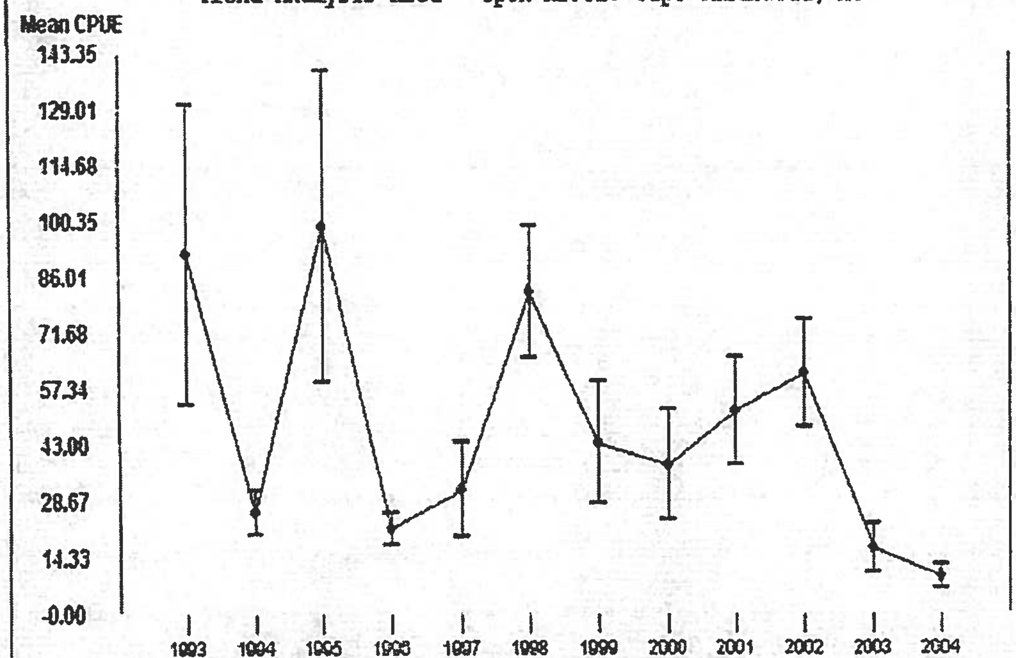
N/A equals not applicable.

Figure 3-1. Twelve-year trend in species richness (Open River: Cape Girardeau, MO).

12-year trends in Catch Per Unit of Effort (CPUE), 1993–2004

Gizzard shad collected by Day electrofishing in ALL strata

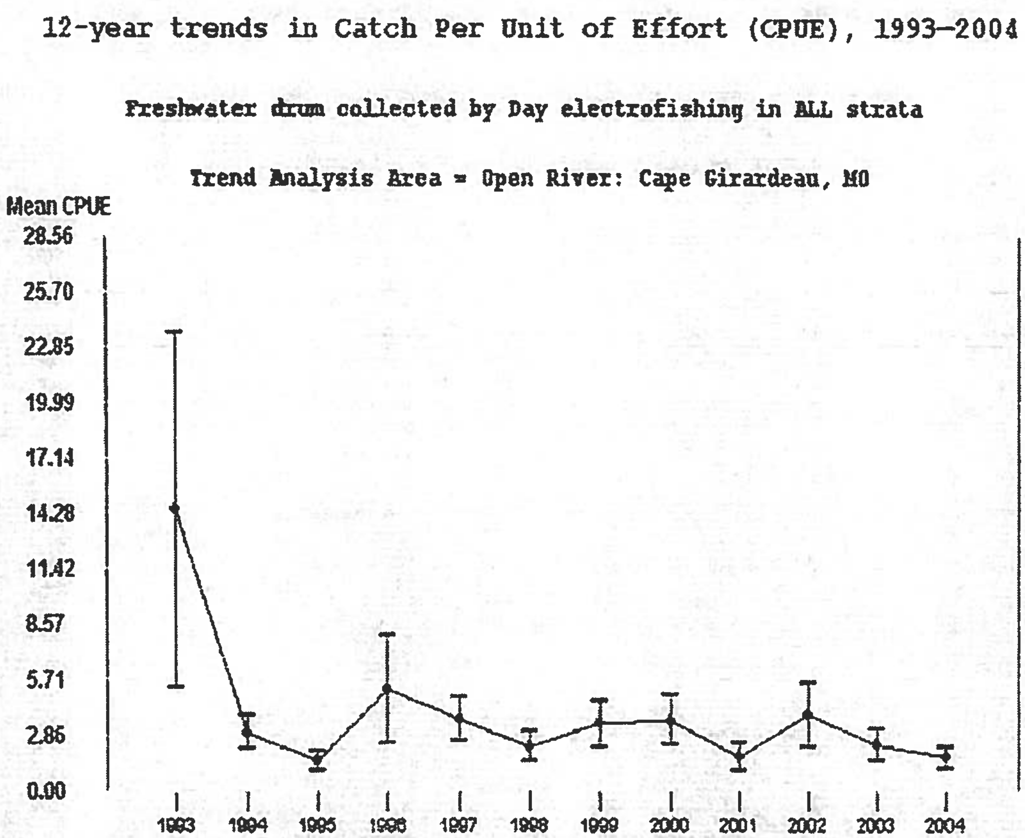
Trend Analysis Area = Open River: Cape Girardeau, MO



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	91.45	129.78	53.13	17
1994	25.14	30.79	19.49	42
1995	98.47	138.35	58.60	54
1996	21.06	25.12	17.01	52
1997	31.15	43.02	19.28	55
1998	81.62	98.50	64.75	37
1999	42.89	58.62	27.17	49
2000	37.26	51.42	23.10	53
2001	51.01	64.67	37.36	57
2002	60.74	74.72	46.75	57
2003	16.19	22.28	10.09	27
2004	8.99	11.98	6.00	45

N/A equals not applicable.

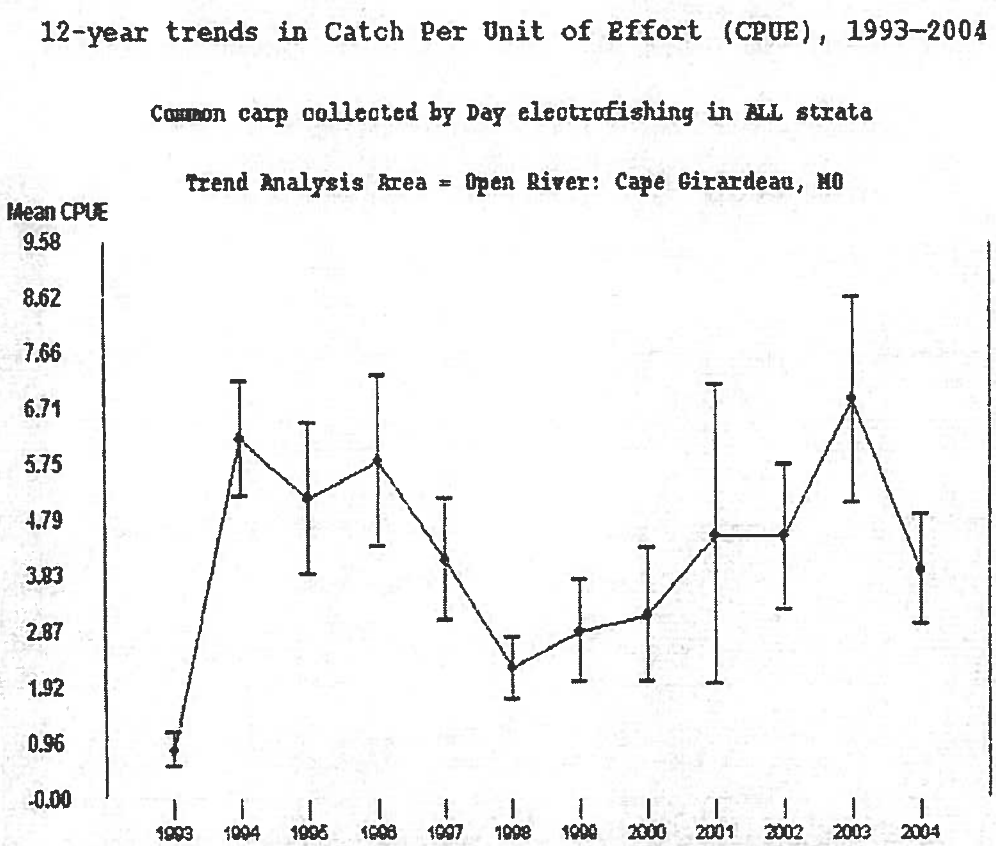
Figure 3-2. Twelve-year trend in catch of gizzard shad (Open River: Cape Girardeau, MO).



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	14.40	23.56	5.26	17
1994	2.95	3.84	2.06	42
1995	1.53	2.04	1.02	54
1996	5.14	7.89	2.40	52
1997	3.63	4.79	2.48	55
1998	2.24	2.99	1.50	37
1999	3.39	4.58	2.21	49
2000	3.55	4.82	2.30	53
2001	1.66	2.42	0.92	57
2002	3.82	5.45	2.19	57
2003	2.30	3.16	1.44	27
2004	1.66	2.24	1.08	45

N/A equals not applicable.

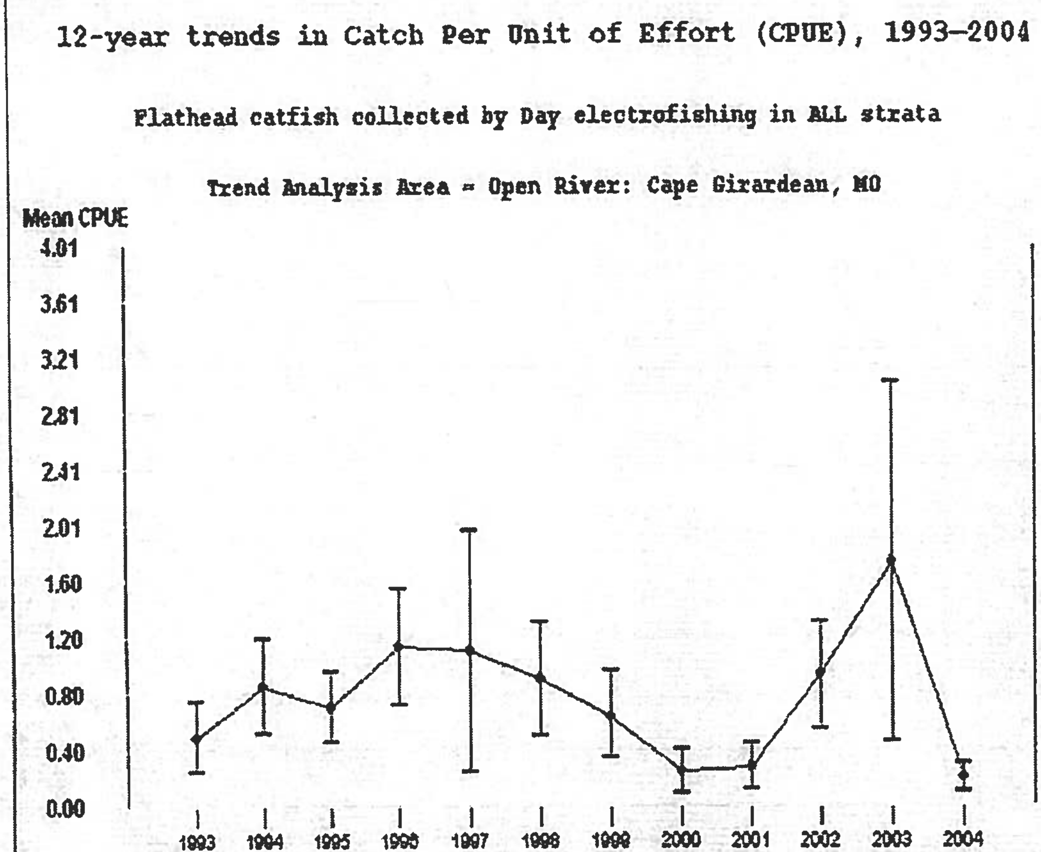
Figure 3-3. Twelve-year trend in catch of freshwater drum (Open River: Cape Girardeau, MO).



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	0.81	1.10	0.53	17
1994	6.14	7.14	5.16	42
1995	5.12	6.43	3.83	54
1996	5.77	7.23	4.31	52
1997	4.07	5.10	3.04	55
1998	2.19	2.73	1.65	37
1999	2.82	3.70	1.96	49
2000	3.11	4.25	1.98	53
2001	4.48	7.05	1.93	57
2002	4.45	5.68	3.21	57
2003	6.81	8.58	5.05	27
2004	3.90	4.83	2.97	45

N/A equals not applicable.

Figure 3-4. Twelve-year trend in catch of common carp (Open River: Cape Girardeau, MO).



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	0.48	0.74	0.23	17
1994	0.84	1.18	0.51	42
1995	0.69	0.95	0.45	54
1996	1.12	1.54	0.71	52
1997	1.10	1.96	0.24	55
1998	0.89	1.29	0.50	37
1999	0.63	0.95	0.33	49
2000	0.24	0.40	0.08	53
2001	0.26	0.43	0.11	57
2002	0.92	1.30	0.54	57
2003	1.73	3.01	0.45	27
2004	0.19	0.29	0.09	45

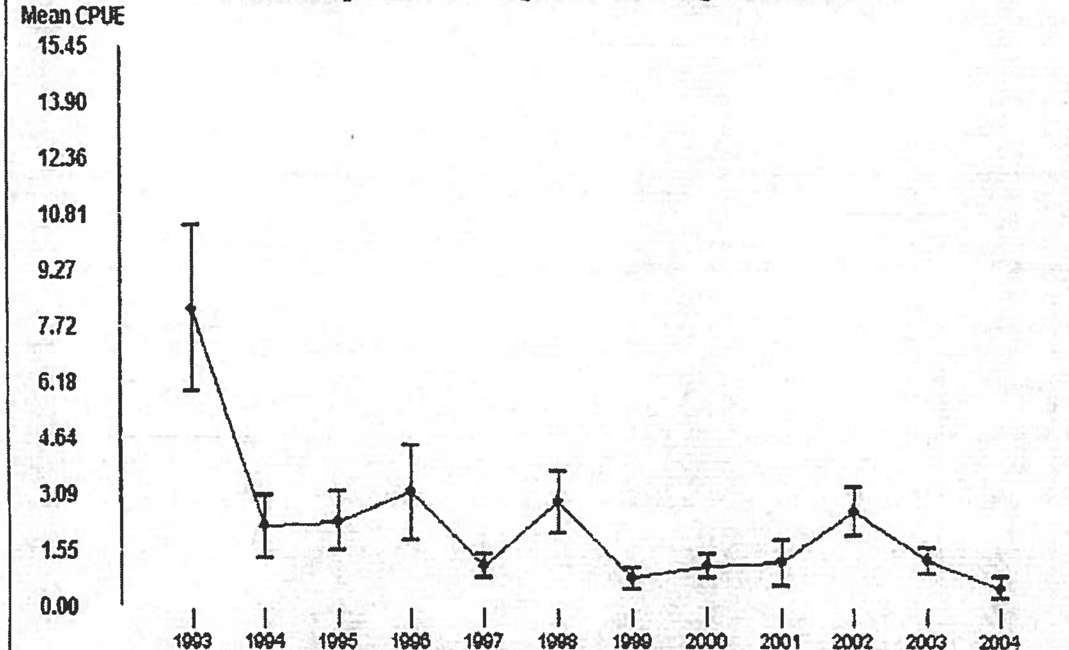
N/A equals not applicable.

Figure 3-5. Twelve-year trend in catch of flathead catfish (Open River: Cape Girardeau, MO).

12-year trends in Catch Per Unit of Effort (CPUE), 1993–2004

White bass collected by Day electrofishing in ALL strata

Trend Analysis Area = Open River: Cape Girardeau, MO



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	8.14	10.45	5.85	17
1994	2.16	3.02	1.32	42
1995	2.31	3.12	1.51	54
1996	3.09	4.38	1.80	52
1997	1.10	1.43	0.77	55
1998	2.82	3.68	1.97	37
1999	0.73	1.02	0.44	49
2000	1.07	1.40	0.74	53
2001	1.17	1.82	0.53	57
2002	2.57	3.23	1.90	57
2003	1.23	1.60	0.87	27
2004	0.48	0.80	0.17	45

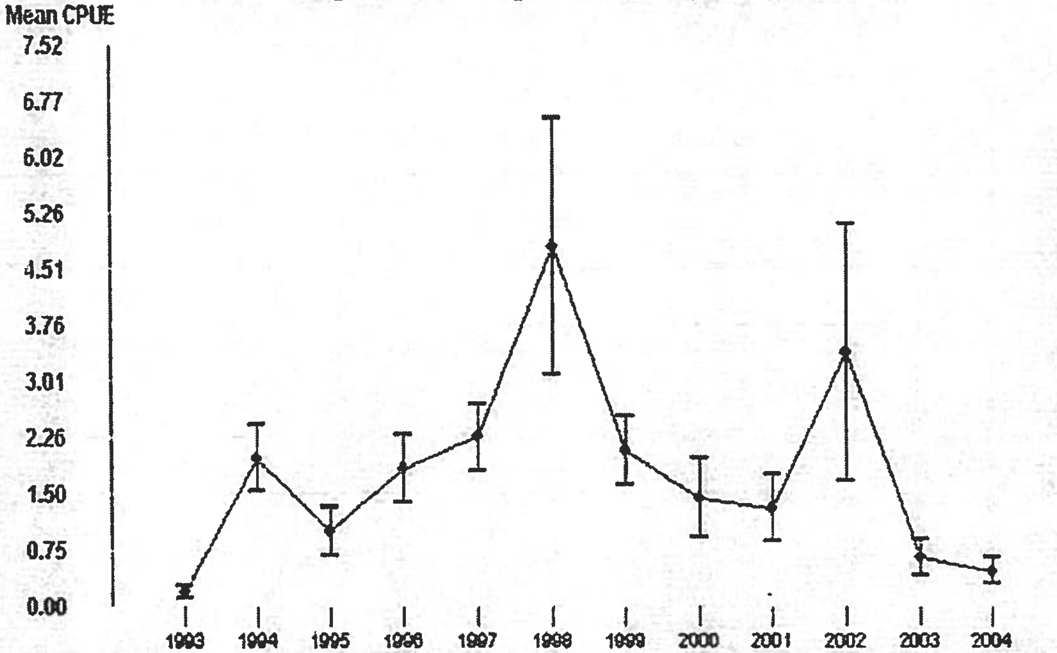
N/A equals not applicable.

Figure 3-6. Twelve-year trend in catch of white bass (Open River: Cape Girardeau, MO).

12-year trends in Catch Per Unit of Effort (CPUE), 1993–2004

Channel catfish collected by Day electrofishing in ALL strata

Trend Analysis Area = Open River: Cape Girardeau, MO



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	0.17	0.26	0.09	17
1994	1.96	2.40	1.53	42
1995	0.98	1.30	0.67	54
1996	1.81	2.27	1.36	52
1997	2.23	2.68	1.78	55
1998	4.79	6.52	3.07	37
1999	2.05	2.51	1.59	49
2000	1.42	1.95	0.90	53
2001	1.28	1.72	0.85	57
2002	3.38	5.09	1.66	57
2003	0.63	0.87	0.40	27
2004	0.45	0.63	0.27	45

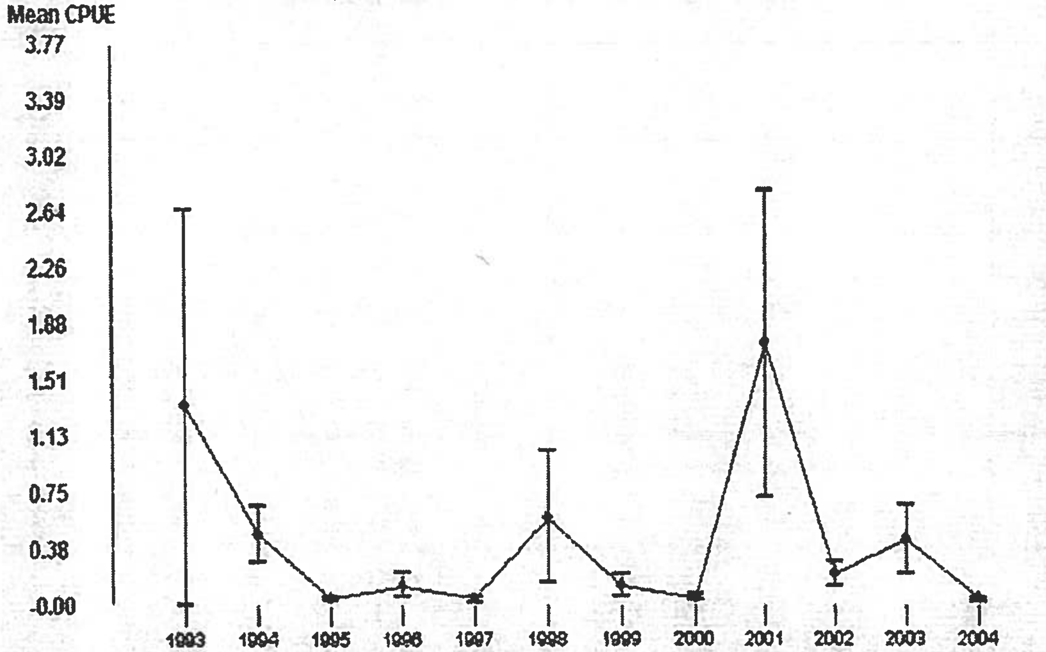
N/A equals not applicable.

Figure 3-7. Twelve-year trend in catch of channel catfish (Open River: Cape Girardeau, MO).

12-year trends in Catch Per Unit of Effort (CPUE), 1993–2004

Bluegill collected by Day electrofishing in ALL strata

Trend Analysis Area = Open River: Cape Girardeau, MO



Year	Mean CPUE	+1 Standard Error	-1 Standard Error	Number of Samples
1993	1.32	2.64	0.00	17
1994	0.46	0.65	0.28	42
1995	0.03	0.05	0.02	54
1996	0.12	0.21	0.05	52
1997	0.03	0.05	0.01	55
1998	0.57	1.02	0.14	37
1999	0.12	0.20	0.05	49
2000	0.04	0.06	0.02	53
2001	1.74	2.77	0.71	57
2002	0.19	0.27	0.11	57
2003	0.43	0.65	0.20	27
2004	0.03	0.04	0.01	45

N/A equals not applicable.

Figure 3-8. Twelve-year trend in catch of bluegill (Open River: Cape Girardeau, MO).

4. PROPOSED IMPINGEMENT MONITORING

As discussed in Section 2.3.1, a complete year of impingement data was collected at the Rush Island Power Plant during the 1977-1978 impingement monitoring program. This sampling provided useful data on impingement at Rush Island during that time period. However, the plant's intake operation and the fish community in the middle Mississippi River may have changed sufficiently since then to affect impingement at Rush Island, in particular the species composition and magnitude of impingement.

The objective of the proposed impingement monitoring program is to update the existing impingement data to reflect current conditions in the river and current operation of the plant. Data produced by this monitoring program will define the species and life stages impinged, as well as their numbers and biomass on a time (biweekly, monthly, and annual) and per-volume-pumped (million gallons of cooling water) basis. The results will be incorporated into the IM Characterization Study, as described in Section 1.2.

This section addresses the proposed sampling plan, sampling gear and the method for its deployment, sample processing procedures, the collection of relevant ancillary information, and data analysis. A quality assurance program for the impingement monitoring program is described in Section 5.

4.1 SAMPLING DESIGN

The impingement monitoring program is proposed to span one year (12 months) and to include both units. A second year of monitoring may not be necessary if the magnitude of impingement and/or the species and life stages impinged do not differ markedly from the results of the 1977-1978 monitoring program, e.g., seasonal or annual impingement totals or rates (average daily or average number per unit volume pumped).

Impingement will be sampled every other week and the traveling screens of both units will be sampled at the same time. If no units are scheduled to operate during the specified biweekly sampling period, a request will be made to turn on a circulating water pump for the duration of sampling in order to get representative density measurements. This biweekly sampling frequency will describe seasonal patterns in impingement as requested in the Phase II Rule.

Sampling will occur over one 24-hour period per biweekly period. Sampling days will be scheduled for the same day(s) in each period (e.g., Tuesday).

4.2 SAMPLING GEAR AND DEPLOYMENT

Prior to sampling, the traveling screens will be rotated for at least one full cycle to remove fish and debris accumulated prior to the sampling interval. Once this cleaning process has been accomplished, the sampling will be initiated by lowering a collection basket into the screen wash trough system that serves both units. The screens will be rotated during the sampling period in a manner typical of normal screen operation, i.e., they will be washed with a frequency necessary to keep them clean. The collection basket or the net liner within it will have ¼-inch square mesh. The sampling crew will monitor the screen wash troughs and collection basket to prevent overflow or snags caused by debris buildup. During periods of very low volume of impinged fish and debris, the collection basket may be left in place for the entire 24-hour collection period. When fish and debris volumes become greater, screens will be rotated and washed as frequently as necessary to reduce the volume of debris and fish being directed to the collection basket at once. At the completion of each sampling, the collection basket will be removed and its contents will be emptied onto a processing table.

If necessary due to heavy debris buildup, screen rotation will be continuous at all screens. In this case, the sampling crew will continuously monitor the screen washwater troughs and the collection basket to prevent snags or overflow caused by ice or debris buildup. To prevent collection basket overflow, the crew will temporarily interrupt sampling, empty the collection basket's contents, and resume sampling, while recording the start and end times of the interruption. If this occurs, the total impingement during the 24-hour sampling period will be estimated by extrapolating from the timed subsamples to a full 24-hour sample.

4.3 SAMPLE PROCESSING

Each sample will be processed by counting and identifying all fish to the lowest practicable taxonomic level. Individual fish that cannot be identified to species in the field will be preserved for identification by taxonomic specialists. Shellfish found in the impingement sample, such as native freshwater mussels, Asiatic clams, zebra or quagga mussels, and crayfish, will be identified to a practicable taxonomic level and will be counted (in the case of few specimens such as native freshwater mussels or crayfish) or weighed in bulk (in the case of numerous Asiatic clams or zebra and quagga mussels).

Fish in the sample will be sorted by species and size category. Two size categories will be established prior to sampling, particularly for frequently impinged species such as gizzard shad, to separate young-of-the-year (YOY) individuals from yearling and older individuals. Size categories will be determined according to cut-off lengths used during the previous biweekly sampling period and anticipated growth, based on observation and literature sources. Following sorting, up to 50 randomly chosen individual specimens within each size category will be measured to the nearest mm total length (TL) and their condition will be recorded as live, dead or stunned. A total batch weight measurement will be taken for each size category.

If the number of specimens in the sample for a particular species and size category is large, then the species/size category count will be estimated by subsampling. A subsample of 100 individuals will be weighed and the total sample will be weighed. The number of individuals in the whole sample will be estimated from the ratio of the total sample weight to the subsample weight total and the count within the subsample. Lengths will be measured for 50 randomly chosen individuals in the subsample.

During each season (e.g., April-June, July-September), scales, finrays, spines or otoliths (depending on species) from 20 measured yearling and older individuals of each of the representative fish species from each 50-mm length interval (e.g., 200 – 249 mm, 250 – 299 mm, etc.) will be removed and stored in individual envelopes or vials. For each sampled fish, the collection date and location, species, and total length will be recorded. These samples may be used, if necessary, to supplement recent size-specific age data available from literature sources for species in the middle Mississippi River. Size-specific age data may be required for application of equivalent loss models as part of a site-specific cost-benefit calculation.

The general condition of impinged fish will be observed as they are processed. Unusual condition, such as signs of disease, parasites or injury, will be noted. Fish that were obviously dead before being impinged (e.g., presence of fungus or decay) will not be included in the sample, but will be noted in field logs. Indications of a mass die-off of fish, such as can occur with gizzard shad (White et al. 1986), will be observed and recorded, and examples of physical evidence (e.g., floating fish in the river or dead fish on shore) will be photo-documented. If available, scientifically defensible methods to detect or predict the occurrence of moribund fish entering the intake will be used to document episodic impingement events that would represent anomalous impingement data.

4.4 RELEVANT ANCILLARY INFORMATION

Ancillary information relevant to environmental conditions at the time of impingement monitoring will be recorded, as well as plant operation data needed to estimate total impingement. Environmental data relevant to each sample will be recorded on an accompanying field data sheet. In addition to date and sample start/end time recordings, these data will include operation parameters for the intake (identify screens and pumps operating), river stage, and water temperature, all recorded at the beginning and end of each collection period. A unique sample identification number will be assigned to each sample. Other relevant observations will be recorded, including river and weather conditions, such as air temperature, wind speed, cloud cover, and precipitation.

Plant operation records will be used to determine the operation regime during the sampled and unsampled days in each month. Data will include hourly pumping rates (or volumes) for each unit, generation output (MWh) and discharge water temperature. Pumping rate or volume data will allow impingement estimates to be based on per unit volume pumped.

4.5 DATA ANALYSIS

The objectives of the impingement data analysis will be to:

1. define the fish species impinged;
2. estimate impingement rates expressed as density per million gallons (MG) of cooling water pumped on a daily, biweekly, and annual basis;
3. estimate total numbers and biomass by species on a daily, biweekly (for seasonal variability), and annual basis for the year of sampling; and
4. characterize impinged fish in terms of size and age distribution by species.

These parameters will be compared to the results of impingement sampling from the 1977-1978 monitoring program to determine whether there are differences that would suggest possibly significant annual variability in impingement at Rush Island. If annual variability is determined to be of concem, a second year of impingement monitoring may be considered, as deemed necessary by Ameren to support the submittal of the CDS. The results will be incorporated into the IM Characterization Study in the CDS, as discussed in Section 1.2.

The estimated total numbers and biomass impinged will represent the actual impingement for the year of sampling. However, the impingement rates expressed as density per million gallons (MG) of cooling water pumped can be used to estimate impingement totals under differing operating scenarios, such as might be required to determine the calculation baseline for the station. To estimate the density of impinged organisms for a particular species, the number of fish of that species collected from all screens will be divided by the total intake flow during the 24-hour sampling period. This density estimate then will be multiplied by the total intake flow during the biweekly period to estimate the total number of impinged fish for the biweekly period. Seasonal totals will be calculated by summing the biweekly totals falling within the season. Annual totals will be the sum of all biweekly totals. The same calculations will be performed for estimating total biomass impinged using weight totals. Plant operation records (hourly pumping rates or volumes for each unit) for sampled and unsampled days in each month will be used to perform this extrapolation.

5. QUALITY ASSURANCE

An essential part of the proposed monitoring program will be a quality assurance plan instituted to ensure that the data generated by the program meet an acceptable standard of quality. Quality assurance (QA) is defined as an integrated system involving quality planning, quality control, quality assessment, quality reporting, and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence. The EPA has published guidance documents (e.g., EPA 2000, 2002a, 2002b) for preparing and implementing project-specific quality assurance plans for their staff and for contractors funded by their organizations to follow, known as Quality Assurance Project Plans (QAPPs). These documents will be used to prepare a QAPP that fits the needs of the proposed impingement program prior to the initiation of sampling.

A QAPP has four basic element groups: project management, data generation and acquisition, assessment and oversight, and data validation and usability. The following highlights aspects that are particularly relevant to the execution of the proposed impingement monitoring program.

5.1 PROGRAM MANAGEMENT

This Impingement Mortality Sampling Plan provides many of the elements necessary for the program management functions of a QAPP, such as problem definition and background, and project and task descriptions. Other program management functions of a QAPP that are provided in the Plan include presentation of the project objectives and the interrelationships among the project tasks that direct the course of studies and identify information endpoints. An important element is the project organization, which identifies the roles and responsibilities of project personnel. A project organization chart identifies project personnel, whose qualifications (e.g., experience and specialized training) can be reviewed, as well as lines of communication and authority. The project organization chart will show individuals whose responsibility is to conduct various aspects of the quality assurance program.

The QAPP will set data quality objectives and criteria. Methods are specified to ensure a desired level of precision, comparability, and completeness. In terms of impingement mortality quantification, the EPA has not set standards for precision of estimates, so the sampling design proposed in this plan is intended to conform to sampling effort and precision levels that are currently standard practice. If the EPA publishes guidance on sampling methods in the future, including QA standards and desired or required levels of precision, the program design and methodology will address those standards.

5.2 DATA GENERATION AND ACQUISITION

This component of the QA program is the heart of the field and laboratory tasks undertaken to collect (generate) data on current impingement mortality at Rush Island. Elements include sampling design, sampling methods, sample handling and custody, analytical methods, instrument maintenance and calibration, and quality control. Quality control is defined as activities whose purpose is to measure and control the quality of a procedure so that it meets the needs of its user. Quality control (QC) activities monitor the outgoing quality of the data and can lead to response actions to bring the data within control limits through various actions, such as retraining of personnel, repair or recalibration of equipment, or other similar actions.

Sampling methods will be standardized so that they are repeatable and produce data that are comparable through time. This will be accomplished by preparing detailed Standard Operating Procedures (SOPs) for all activities, including sampling location and frequency, sampling gear and deployment, sample processing, data coding and recording, database entry, and to some degree, data analysis. The SOPs can be reviewed by all parties to reach consensus on their applicability, and will be adhered to by all project personnel. SOPs will provide a description of procedures to follow if obstacles to sampling or completion of all sampling activities are met, so that the acquisition of quality data can be maximized. The SOPs will describe procedures for sample handling and custody, including required signatures and blank forms for associated labels and logs. Also included will be project-specific data sheets, variable definitions and coding instructions. Equipment and instrument specifications will be described, including levels of precision and calibration methods for ensuring accuracy.

5.3 ASSESSMENT AND OVERSIGHT

Assessment and oversight is the process of determining whether the QA plan is being implemented as designed. For the proposed programs, this will be accomplished primarily by conducting technical audits or surveillance of field, laboratory and data management activities (EPA 2000a). Experienced senior staff, designated by the organization chart, will accompany field personnel during a set number of sampling events to observe sampling activities and to verify that SOPs are being followed properly. These auditors also will observe laboratory and data management personnel during their activities on specified occasions. Variances from approved procedures will be documented and corrected, either by modifying SOPs to address any systematic problems or by testing and/or retraining staff, as necessary. Prior to the first scheduled sampling, a readiness review will be conducted to ensure that trained personnel, required equipment, and procedural controls (e.g., SOPs) are in place. A technical audit will be scheduled for the first month of sampling (or very soon thereafter) so that any necessary corrections can be made before significant data losses occur. Follow-up audits will be scheduled (e.g., quarterly) to monitor progress and address changing conditions, such as recruitment of new life stages or species, impingement abundances, river stage or flow, new personnel, or plant operations.

Another QC aspect for oversight is the maintenance of a voucher specimen collection and a library of approved taxonomic keys and references to assist personnel with taxonomic identification. The voucher specimen collection will consist of preserved specimens that have been positively identified by a qualified taxonomist. Oversight also will be provided by procedures requiring that specimens that are not positively identifiable by field or lab personnel will be preserved and given to a qualified taxonomist for identification.

5.4 DATA VERIFICATION, VALIDATION AND USABILITY

Data verification and validation will be conducted by qualified biologists (e.g., QA manager or field/lab supervisors) during the course of the project to ensure that the resulting data will be suitable for use as intended. Project records, including field sampling logs, raw data sheets, sample chain-of-custody forms and instrument calibration logs, will be reviewed to verify that data were collected according to the QAPP. Data will be validated first by a review of datasheets and data files to find whether data are incomplete or appear to be inappropriate or out of a reasonable range of values. Data entry into the database also will undergo a 100 percent visual QC comparison to the data on the corresponding data sheets. Finally, data files will be subjected to error checking programs to detect outlying values to either investigate further or eliminate if shown to be spurious. This investigation will require tracing the data to raw data sheets and consulting with field or lab personnel who recorded the data. All raw data sheets, log books and data files will be maintained for future reference. All computer files will be backed up on a daily basis while any data entry or editing procedures are ongoing.

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